VOLUME 36
NUMBER 12

DECEMBER, 1949

plating

AIRPLANE PROPELLER PRODUCTION

See Contents Page 1213

POSTMASTER: IF UNDELIVERABLE RETURN TO
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RETURN POSTAGE GUARANTEED

University Microfilms
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Ann Arbor, Michigan

Holiday Greetings

AS Christmas and New Year again approaches, we think of the grand spirit that prevails. It would indeed be wonderful if this spirit continued on throughout the year. Thus, the millennium would be attained, *peace on earth and good-will toward men* established.

★

Frederick Gumm Chemical Company and its employees wish our many friends in the Industry a joyous and happy *Christmas* and *New Year.*

FREDERICK **GUMM** *Chemical Company Inc.*

538 FOREST STREET, KEARNY, N.J.

FOR FURTHER INFORMATION, USE READER SERVICE CARD. INDICATE # 960.

Nickel plated steel scissors stripped clean and bright without attack.

new Developments For Metal Finishing

METAL STRIPPER "A" – An alkaline chemical stripper for removing coatings of nickel, copper, zinc, cadmium and silver from steel *without any attack* upon the steel. Excellent for removing plated coatings as well as surplus metal from brazing or welding.

CLEANER S-61 – A new alkaline soak-type cleaner that is remarkably effective even at temperatures as low as 150°F. for removal of oil, grease, and buffing compounds from copper and steel.

EBONOL "S-30" – A new quick blackening process for iron and steel. Produces jet black coatings in five minutes.

INHIBITOR 9 – A new inhibitor for both hydrochloric and sulphuric acids for pickling of steel without attack. Saves acids. Also inhibits against hydrogen embrittlement.

NYLON ANODE BAGS – New nylon anode bags for nickel, copper, silver and other plating solutions. Made to specifications.

"SURPREP" – A new phosphating type cleaner for rapid removal of rust, oil and grease from large objects. Can be applied by brushing, wiping or spraying.

Write for New Bulletins on these Products

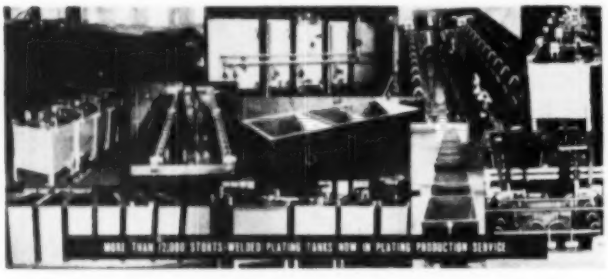
● *Fast action of SURPREP on oily steels*

Enthone INC.

442 Elm Street, New Haven, Conn.

Getting top value in your PLATING TANKS is not a toss-up

Use the STORTS formula—First specify the right materials, rightly designed for your purpose—Then make your fabricating problem our problem, by placing the responsibility in our hands.



Extra profits are often sacrificed when modern process improvements are adopted without utilizing the improvements obtainable in modern plating tank construction. On the other hand, hundreds of tank users have gained utility and economy by taking advantage of Storts engineering service, keeping their tank specifications up to date and making their operating dollars go farther.

STORTS WELDING COMPANY
INCORPORATED
42 Stone Street Meriden, Conn.

Manufacturers of Welded Fabrications to Specifications

Industry News

New York Job Plating Shops. The October issue of The Monthly Bulletin of the Masters Electroplating Association, 123 William Street, New York City, for the first time in many months reported a substantial increase in rate of operations. The 56.2 per cent for October, 1949 compares favorably with the 56.0 per cent for October, 1948 and adds 5.7 per cent to the September, 1949 figure. The data is beclouded by the fact that 10 shops are still strike bound and not reporting.

Water Pollution. The recently organized Water Pollution Control Advisory Board at its second meeting in the beginning of October adopted recommendations to assist the Public Health Service of the Federal Security Agency in carrying out its far-reaching program to improve and safeguard the nation's water resources. Among them were that a firm policy be pursued to insure the abatement of pollution of interstate waters, that the "essentials" of a uniform state law be prepared which could be adopted in part or in whole by states interested in strengthening their water pollution control activities, that special grants for study and research projects having sectional or national significance be continued and that preference be given to projects in which industry cooperates by supplying funds or skills, and that a technical committee be established to review projects for special funds and pass on allotments to be approved finally by the Public Health Service.

Walter C. Gold, Incorporated, 112 N. Front Street, Philadelphia, Pa., has been appointed sales and service representative in the Philadelphia area by the **Daniels Plating Barrel and Supply Company,** Newark 5, N. J. This territory covers Pennsylvania, east of Pittsburgh.

E. F. Houghton & Co. Changes Eastern Sales Division. The Eastern Sales Division of E. F. Houghton & Company has been split into two sections: Eastern Sales North, which will include New England and New York State, and Eastern Sales South, including Pennsylvania, New Jersey and Delaware. Orum R. Kerst will head the north section, and J. R. Clendenning will take over the south. A. C. Smith, former assistant to the eastern sales manager, has been promoted to the newly created post of sales coordinator for the two eastern sections.

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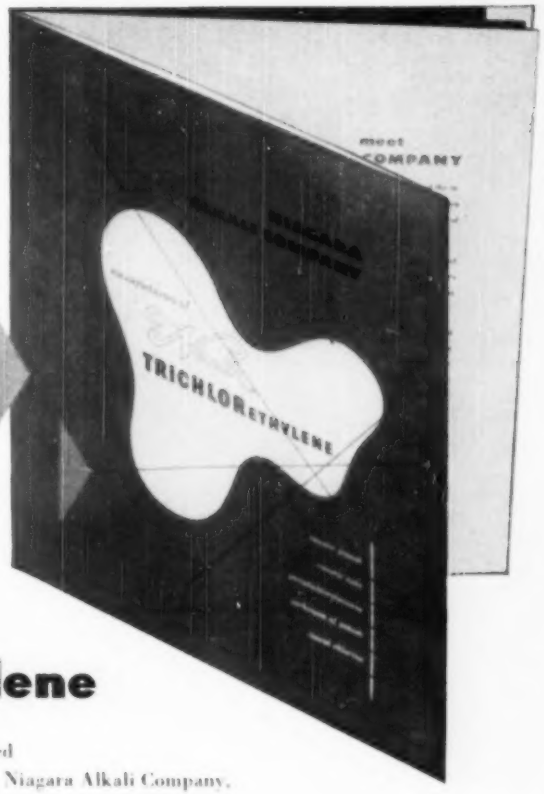
for
high
quality
and superior
stability



NIALK TRICHLORethylene

NIALK TRICHLORethylene is produced in a new plant at Niagara Falls, N. Y. by Niagara Alkali Company, one of America's pioneer chemical companies.

This new plant is completely modern and utilizes control equipment that satisfies the most exacting demands for a product of high quality and superior stability. It readily permits increased production to meet expanding demands.

WHAT YOU WANT TO KNOW about NIALK TRICHLORethylene and Niagara Alkali Company is contained in the booklet illustrated here. The coupon below will bring you a copy.

NIAGARA ALKALI COMPANY

60 East 42nd Street, New York 17, New York

Liquid Chlorine · Caustic Potash
Carbonate of Potash
Paradichlorobenzene
Caustic Soda
NIALK TRICHLORethylene

Niagara Alkali Company, Dept. A,
60 East 42nd Street, New York 17, N. Y.

Gentlemen: Please send me a copy of your booklet on NIALK TRICHLORethylene.

Name_____

Position_____

Firm_____

Street_____

City_____ State_____

Industry News

Guild Laboratory, P. O. Box 3194, Barnum Station, Bridgeport, Conn., is an electrochemical laboratory recently established by Victor H. Peretti and registered in the City of Bridgeport.

It is said to have developed, and will soon market, a new type portable-plating set known as the Guild Plate-Kit, which needs only an ordinary 110-volt A.C. power source. This self-contained plating apparatus will be most serviceable to laboratories, jewelry and precious-metal repairers, schools and hobbyists.

Plating solutions and concentrates of nickel, silver, cadmium, and brass are offered, also consulting service.

Commercial Filters Corporation of Boston, Mass., manufacturers of Fulflo Filters and Cartridges for filtration of all industrial and commercial fluids, has opened a Midwestern sales office at 603 W. Washington Boulevard, Chicago, Ill. The new office will be in charge of Walter H. Magee.

Film About Zinc. The story of zinc is dramatized in a 34-minute sound motion picture sponsored by the St. Joseph Lead Company in cooperation with the United States Bureau of Mines and produced by the Atlas Film Corporation.

"Zinc—Its Mining, Milling and Smelting" traces the story of zinc from the mining of the crude ore to the gleaming blue-white slabs at the end of the complex production process. It opens with a brief discussion of the importance of zinc in everyday life of America. An Atlas camera crew and director moved to a mining community in New York State—site of a large zinc mine—to get shots of miners at work.

Animated diagrams explain the complex processes through which the ore passes in the preparation of metallic zinc and zinc oxide—crushing, screening, chemical separation and flotation, roasting, sintering, smelting in electric furnaces, etc.

The film is available for distribution through the Film Library of the United States Bureau of Mines at Pittsburgh.

E. H. Sargent & Company Completes Chicago Plant. E. H. Sargent & Company, manufacturers and distributors of scientific laboratory instruments, apparatus and chemicals, have completed a new one-story steel-concrete-and-brick building at 4647 W. Foster Avenue, Chicago 30, Ill. It occupies approximately three acres of the five-acre tract and houses complete engineering, production, merchandise-handling and warehouse facilities, including engineering and drafting offices; complete instrument factory, physical and chemical laboratories; preparation laboratory; glass-blowing shop with grinding and graduating facilities; all-steel merchandise-storage structures with fireproof storage rooms for hazardous chemicals; inspection department; and packing room equipped with the latest type belt-conveyor system.

The company extends an invitation to all readers to inspect the new plant whenever they are in the vicinity of Chicago.

Electrodepositors Technical Society's Program of Meetings lists a series of lectures to be held in London, Birmingham, and Sheffield, England, during the 1949-1950 season. Those who intend to visit England should contact the Society's London headquarters, 27 High Street, Islington, London N. 1 for further information.

Allied Research Products, Inc., Baltimore, Md., has purchased the building at 4004 E. Monument Street which has housed the company for the past three years.

Plans are being drawn up for extensive renovations to the interior. These will include larger research-laboratory facilities, expanded manufacturing facilities for new Iridite products soon to be announced, and more space for the company's metal-finishing operations. New offices for the administrative and sales staffs will also be erected.

Platecoil Adds Representatives in Midwest. Four new representatives have been added in the Midwest by the Platecoil Division of the Kold-Hold Manufacturing Company, Lansing, Mich. They are **The Henry P. Thompson Company**, Cincinnati; **Power Plant Efficiency Company**, Indianapolis; **Patton Equipment Company**, St. Louis; and **W. P. Nevins Company**, Chicago.

Here's the New, Proved

faster
TROUBLE-FREE WAY
to produce
MIRROR-LIKE FINISHES
ON NICKEL

Now, your finishing room can finish nickel to a mirror-like gloss or prepare nickel for chrome plating faster, easier—with *Speedie* Bright Gloss (Lime).

- No. 86-D is an excellent material for cutting and is fairly greasy so that it readily sticks to the wheel.
- No. 1641 is particularly recommended for work that is to be chrome plated after buffing since it is 100% saponifiable and prevents discoloration of the work.
- No. 1931 is a recently developed product which is ideal for heavy work such as bumpers. A good cutter "for tough jobs".

Learn more about the many other *Speedie* "laboratory-quality", job-proved products . . . Tripoli, Stainless Steel, Satin Finish, Emery Cake, Grease Stick, etc. Write Dept. M.F. for your FREE catalog today.

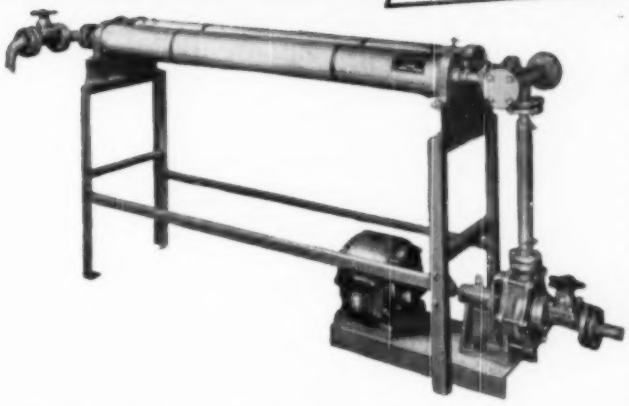
Polishing Room Supplies and Accessories

BP
THE BUCKEYE PRODUCTS CO.
7033 Vine Street Cincinnati 16, Ohio
Cable address: Buckprod

FOR FURTHER INFORMATION, USE READER SERVICE CARD: INDICATE A 954.

Industrial's HEAT EXCHANGERS

FOR PLATING SOLUTIONS



The Same Unit for Heating and Cooling

That's one big advantage of INDUSTRIAL'S Unit Heat Exchangers — you use the same unit for both heating and cooling. Maintaining the desired working temperature, by continued heating or cooling in the one unit, simplifies controls and operation. The units are adaptable to either manual or automatic control.

INDUSTRIAL'S Unit Heat Exchangers are available complete with pump and stand, or tubes alone can be had for wall or ceiling mounting. A wide choice of capacity, too, is possible by using from one to six tubes in a unit. Special units are readily engineered to meet unusual capacity or space requirements.

The design of the unit heat exchanger permits the use of pure nickel, copper, steel, or special alloy for the heat exchanger tubes, depending upon the plating solution. Rubber-lined headers and diaphragm valves are used when required. The pumping unit is of an alloy suitable to the solution involved. Ease of inspection and cleaning is assured by a simple header construction.

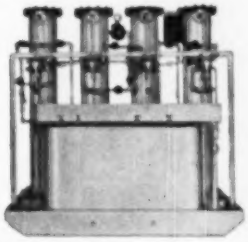
★ *Write for full information and recommendations*

INDUSTRIAL'S WATER DEMINERALIZERS and WATER SOFTENERS

for

Water that leaves no stains after hot rinse

Water that causes no unwanted precipitates in solutions

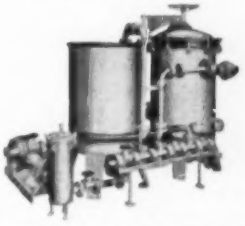


Model L-200 Four-Bed Industrial Water Demineralizer for a nominal flow rate of 200 gph. Other standard models available with capacities of 5 to 1000 gph. Special units of any capacity engineered to requirements.

INDUSTRIAL'S FILTERING SYSTEMS

for

Dependable Results in Solution Clarification



A typical Industrial Stationary Filter System. Standard models—portable and stationary types—are available in capacities of 100 to 15,000 gph. Special filters are engineered to meet unusual requirements.

INDUSTRIAL FILTER & PUMP MFG. CO.

1635 West Carroll Avenue • Chicago 12, Illinois

FILTERS
Pressure Type

PUMPS
Centrifugal

CORROSION TESTING APPARATUS
Salt Fog
Humidity

RUBBER DIVISION
Vulcanized Linings • Molded Products

WATER DEMINERALIZERS

Industry News

Pioneer Steel Ball, Incorporated, Unionville, Conn., has announced the installation of new ball-processing equipment which enables it to offer carburized steel bearing balls from 1/16 to 3/4 inch in diameter. This marks the third expansion in less than three years. Originally lodged in a one-building plant of 4,000 sq ft., the company now occupies factory and office buildings totaling over 30,000 sq ft.

In addition to carburized bearing balls, Pioneer manufactures lapping balls, stainless steel balls, burnishing balls and other metallic shapes for use in burnishing or tumbling barrels.

Oakite Products, Inc., San Francisco Office, formerly of 95 Market Street, Oakland, Calif., have moved to new quarters, Room 572, Monadnock Building, 681 Market Street, San Francisco 5, Calif.

Daniels New Lasalco Distributor. Lasalco, Incorporated, 2818-2838 La Salle Street, St. Louis 4, Mo., manufacturer of electroplating and polishing equipment and supplies, has announced the appointment of **Daniels Plating Barrel & Supply Company,** 129 Oliver Street, Newark 5, N. J., as distributor for its products in Northern New Jersey. Complete information on all Lasalco equipment and products may be obtained through this office.

The National Production Exposition, sponsored by the Chicago Technical Societies Council, has been scheduled for April 4-8 at the Stevens Hotel, Chicago. John C. Tooby, 176 W. Adams Street, Chicago 3, Ill., has been appointed Exhibit Manager of this Exposition which is an outgrowth of the Chicago Production Show, sponsored annually by the C.T.S.C. since 1943.

With an unusual floor-plan layout, the Exposition will accommodate two hundred and eleven exhibit booths in the Stevens Exhibition Hall. The Show hours will be from 1:00 P. M. through 10:00 P. M.

Instrument Course. The Fischer & Porter Company, East County Line Road, Hatboro, Pa., announces that its next instrumentation course will be held at the Hatboro plant, January 23-27.

This course will cover manufacture, calibration, installation, operation and maintenance of primary and secondary process-control instruments. Users of the company's line of Flowrator instruments will find the course particularly valuable.

ONE solvent, ONE price for all jobs

The new Blacosolv is the most stable solvent we've ever offered for metal degreasing. Aluminum, steel, copper and precious metals may be safely and scientifically degreased with the same solvent.

Blacosolv contains a mixture of entirely new and different stabilizers. They are not alkaline materials which neutralize acid *after* breakdown. They are new stabilizers that *prevent* solvent breakdown and possible acid formation. Contains no alkaline materials that can be mistaken for stability - - - - no masking agents are added.

G. S. BLAKESLEE & CO.

BLACOSOLV DEGREASERS AND SOLVENT

NIAGARA METAL PARTS WASHERS

G. S. BLAKESLEE CO. CHICAGO 50, ILLINOIS
NEW YORK, N. Y. TORONTO, ONT.

AGENTS WANTED

Wanted: Manufacturer's agents in certain districts to sell McKEON's "LIQUID SULPHUR", McKEON's "ZINC BRITE", McKEON's "TIN STRIP", etc. *Write to:*

SULPHUR PRODUCTS CO.
Greensburg, Pennsylvania

WANTED
SALESMEN AND JOBBERS

A comparatively new company, which has an excellent line of buffing compounds, rouge, steel and lime bars, and wishes to establish national distribution, is seeking salesmen and jobbers. This company is currently selling its products to an impressive list of manufacturers in its own area. If interested, address reply to:

P-7A, PLATING
P. O. Box 168, Jenkintown, Pa.

SITUATIONS OPEN

TOP FLIGHT MANUFACTURING AGENTS AND JOBBERS Wanted in certain territories to sell Schaffner's Buffing Compositions and Supplies. We specialize in White Finish (Lime, Compositions), Grease Stick, Tripoli, Emery Cake, etc., in "Bar or Liquid Form". All up to 100 per cent saponifiable. These items can all be made to fit your particular customers' requirements. No account is too small or too large for our individual attention.

SCHAFFNER MANUFACTURING COMPANY
Schaffner Building
Pittsburgh 2, Pa.

And NOW
ROHCO *Bright Zinc Plating* MAGIC!

ROHCO
RESEARCH
Introduces
Pellet
Barrel Zinc
Brightener . . .

For just a few pennies—drop a PELLET into the load and have it come out bright without bright dipping. Even in multiple barrel units, you can select brightness and have one or more barrels produce bright work at will with highest throwing power and covering power.

ROHCO PELLET ZINC BRIGHTENER is a special, slow dissolving, concentrated product that feeds brightener as required to the zinc solution in the cylinder.

Obviously, ROHCO PELLET ZINC BRIGHTENER provides the ultimate in economical use of the temporary type of zinc brightener as it is not wastefully dispersed throughout the entire plating tank.

SEND TRIAL ORDER TODAY!!!

ROHCO

ROHCO PRODUCTS

NO-CRO-MIST . HULL CELL TEST . ROHCO 20XL . ROHCO RINSE-AID CRŌMETER . ROHCO PELLET BARREL ZINC BRIGHTENER

R. O. HULL & CO., INC.
1277 West 3rd Street
Cleveland 13, Ohio

"YOUR PLATING IS BEST WITH THE HULL CELL TEST"

JUST PIN THIS COUPON TO YOUR LETTERHEAD

R. O. HULL & CO., INC.
1277 West 3rd Street
Cleveland 13, Ohio

Gentlemen:

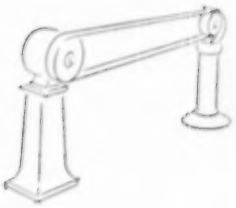
Send 5, 10, 25 lbs. ROHCO P-B ZINC BRIGHTENER (Circle number lbs. desired)

Name .....

Company .....

Address .....

City & State .....



BACKSTAND-BELT GRINDING INCREASES PRODUCTION IN POLISHING AND FINISHING

The coated abrasive belt used in conjunction with a contact wheel and a backstand idler, is established as an efficient production tool. For grinding, polishing and finishing hundreds of consumer and industrial items, the backstand-belt method has proved much more efficient and economical than the old set-up wheel method.

Five Advantages

Manufacturers who have switched from the set-up wheel method point to five distinct advantages of the backstand-belt method over the set-up wheel . . .

● An abrasive belt is a scientifically made tool, manufactured under controlled atmosphere conditions by experts utilizing modern making equipment. The photomicrographs compare the crude, uncontrollable rolled-on cutting surface of typical set-up wheel (A) with the coating on an Armour Abrasive Belt (B). Note how the sharp cutting points on the factory-coated belt are exposed to provide faster, cleaner cutting action—increased production.

A B

● The coated abrasive belt cuts cooler because of the longer interval between work contacts.

● Inexperienced help can be quickly trained to operate a backstand-belt machine. Highly-skilled personnel needed to dress the set-up wheels can be used elsewhere.

● It takes only a few seconds to change an abrasive belt.

● The temperature-controlled room used for curing set-up wheels can be released for other more productive uses.

Actually, there are many more advantages to the backstand-belt method. The following is indicative of what the backstand-belt method could do for you.

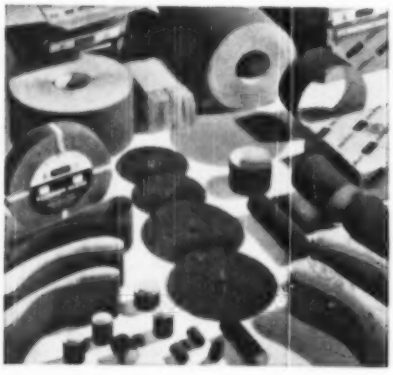
Case History

The W. L. and Metals Company had always used a hard, set-up polishing wheel on aluminum sand castings for aircraft and transportation industries. The wheels had to be inspected constantly for out-of-roundness. This caused a waste of time, closed the snagging operations.

When the company changed to the backstand-belt method, removing gates and fins from castings was no longer a drawback to production. With this new method abrasive costs were lower and the finish much better. The entire operation was speeded up fifty to sixty per cent. . . . wheels no longer needed truing.

If you are now using set-up wheels for your grinding, polishing and finishing operations, it will pay you to investigate the modern backstand-belt method. To do this, write today to the Coated Abrasives Division, Armour and Company, North Benton Road, Alliance, Ohio, for the additional information contained in our new booklet—"Facts about Backstand-Belt Grinding and Polishing."

Need Coated Abrasives? Call Armour!



Backstand belts are only one item in Armour's complete line of coated abrasives. Alundum, Garalun, Garnet and Crystolon come in rolls of paper, cloth or combination . . . in sheets for hand sanding in belts, discs, and other specialized forms.

Whatever your products or specialized needs . . . one of Armour's complete line of metal-working abrasives is *right* for you.

We recommend buying through your Industrial Distributor.

ARMOUR *Coated Abrasives Division*

Armour and Company • North Benton Road • Alliance, Ohio

Personals

Yoder

Clayton P. (Bill) Yoder has been appointed Sales Manager of the Platecoil Division of the Kold-Hold Manufacturing Company. His immediate activities will include establishing sales representation in the leading industrial areas of the country.

Yoder was associated with the General Electric Company for many years, the last ten as head of the Standardizing Laboratory at Erie, Pa. In 1926, he joined the Erie County Electric Company as a Power Sales Engineer and later was promoted to Sales Manager. From 1931 until he started his own business in Buffalo, N. Y., he was connected with the Buffalo Niagara and Eastern Power Corporation.

Stabile

Samuel J. Stabile has been appointed Secretary-Treasurer of Sulphur Products Company, Greensburg, Pa. He is an honor graduate of St. Vincent College, receiving his B.Sc. degree in business administration in 1948.

Charles Kemen has been appointed Sales and Service Engineer representing Klem Chemicals, Inc., Dearborn, Mich., in the Milwaukee area. A graduate chemical engineer of the University of Detroit he will devote his entire time to chemical processing problems and servicing of Klem products. His address is Klem Chemicals, Inc., 312 Wisconsin Avenue, Suite 207, Milwaukee, Wis.

Wilfred S. McKeon, President of Sulphur Products Company, was discharged from the Westmoreland Hospital on October 30 after a three-weeks' siege of high

CHEMICALS ACP PROCESSES

PHOSPHATE FINISHES TO MAKE YOUR PRODUCT DURABLE

Duridine

Phosphate-coats and cleans sheet metal products in mild steel equipment for a lasting paint finish. Duridizing is sludge-free, low in cost, and simple in operation.

COLD SPRAY
Granodine

Forms a zinc phosphate-coating bond on sheet steel products—automobile bodies and fenders, refrigerator cabinets, etc.—for a durable, lustrous finish. Granodizing is a rapid, low-temperature process.

Thermoil Granodine

Creates a dense iron and manganese phosphate coating on steel, which, when oiled, provides exceptional resistance to rust and wear. The coating also provides a most effective paint bond.

Lithoform

A phosphate-coating chemical for galvanized iron, galvanneal, and other zinc or cadmium surfaces. Makes paint stick!

Write—or call Ambler 0486—for more information on these products, and advice on your own metal-working problem.

CHEMICALS ACP PROCESSES

RUST PROOFING AND PAINT BONDING
Granodine ®
Duridine ®
Aladine ®
Li'Sodium ®
Thermoil Granodine ®

RUST REMOVING AND PREVENTING
Dresidine ®
Peralux ®

PICKLING ACID INHIBITORS
Rodine ® ®

Pioneering Research and Development Since 1914

AMERICAN CHEMICAL PAINT COMPANY

AMBLER, PA.

Manufacturers of Metallurgical, Agricultural and Pharmaceutical Chemicals

FOR FURTHER INFORMATION, USE READER SERVICE CARD: INDICATE A 969.

Personals

blood pressure and hypertension. He is reported to be slowly recovering and will convalesce for some time.

MacWatt

Kenneth H. MacWatt is now Director of Engineering Sales of the L. O. Koven & Brother, Inc., Jersey City, N. J., manufacturers of boilers, tanks, and special process equipment. He succeeds W. D. Birch who resigned to assume more active control of his many outside interests.

Mr. MacWatt is a graduate of Stevens Institute of Technology, class of 1931, with a degree of Mechanical Engineer. First employed by the Tidewater Oil Company, he later joined the Alco Products Division of American Locomotive Company in an engineering capacity. With Gibbs & Cox, Inc. from 1941 to 1946, Mr. MacWatt held the position of Naval Coordinator, in charge of contracts with the Navy Department. After the war he returned to American Locomotive Company.

E. H. Ehlert has been appointed Regional Manager of industrial cleaning equipment and chemical sales for midwestern states by Detrex Corporation, Detroit 32, Mich. Mr. Ehlert, whose headquarters will be in Chicago, studied mechanical engineering at Case School of Applied Science and was in business for himself for ten years before he joined the field sales and service staff of Detrex in 1943. In 1948 he was made Manager of the Detroit industrial sales office.

W. J. Miller, who also joined Detrex early in 1943, has been placed in charge of the field application of Detrex alkali and emulsion cleaning compounds and coating materials in the midwestern states.

Allison

E. W. Allison has been elected Secretary-Treasurer of Detrex Corporation, Detroit 32, Mich., succeeding **G. E. Powers** who retired after 25 years with the company. Mr. Powers will act as consultant on financial matters and will remain on the Board of Directors.

Alef

Marvin J. Alef is now Executive Vice-President of Saginaw Industries Company, Saginaw, Mich., one of the oldest stamping and plating concerns in the country and manufacturer of automotive grilles and other products.

Dodd S. Carr has joined the staff of the electroplating group at the Research Laboratory, The International Nickel Company, Bayonne, N. J. He comes from Baltimore.

Arthur Dolnick, formerly of E. F. Drew Company, has been appointed research director of Alrose Chemical Company, Providence, R. I. **Mitchell Chalek** from E. F. Drew Company has joined the research and development staff. **Harry Kroll,** who has been in charge of organic research at the Alrose Company, has left to accept a National Cancer Research Fellowship.

Is METAL PARTS CLEANING a bottleneck in your plant?

A complete line of OPTIMUS Equipment is available in standard and special sizes to meet every metal parts cleaning problem and allied processing applications.

OPTIMUS VAPOR DEGREASERS are available in all various types and stages, straight vapor, vapor-spray, liquid-vapor and combinations of these. All sizes from simple batch type degreasers to custom built monorail or cross rod conveyor models.

OPTIMUS METAL PARTS WASHERS — single or multiple stage — screw or conveyor, mesh belt or monorail types. Can be applied to a wide range of operations as well as the handling of rust preventatives and other coatings.

OPTIMUS DRYERS embody a specially designed system of directional air jets which assure spotless drying after plating or polishing and before subsequent painting, plating or lacquering.

Submit your metal parts cleaning problem to our engineering staff.

Distributors of
"Midsolv"
A Perchlorethylene Degreaser Solvent
"Tricleno D"
A Trichlorethylene Degreaser Solvent

Send for complete catalog and additional information

OPTIMUS EQUIPMENT COMPANY
13 Water Street Matawan, N. J.
Offices in principal cities

OPTIMUS EQUIPMENT
FOR CLEANING · RINSING · DEGREASING · PICKLING AND DRYING OF METAL PARTS

Pro-Seal

REG. U.S. PAT. OFF.

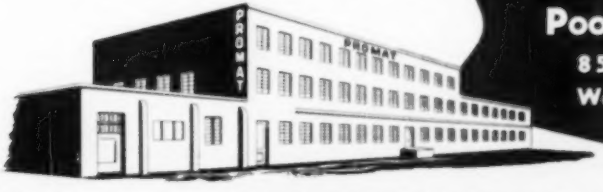
Bright, protective finish for zinc

Pro-Seal is a development of one of the finest laboratories in the plating field.

. . . like "Sterling" on Silver

There is no finer finish for a zinc surface than Pro-Seal. Specified for the majority of refrigerator shelving, the Pro-Seal finish is your answer where a combination of extreme brilliance and unparalleled protective value is required. Data on request.

Dedicated to Research for the Improvement of Metal Finishing



PROMAT DIVISION
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Personals

Morris

Melville Morris is now President of Optimus Equipment Company, Matawan, N. J., manufacturers of vapor degreasers, metal-parts washers, pickling and drying equipment. Mr. Morris has been Executive Vice-President of the company, which is a subsidiary of Hanson-Van Winkle-Munning Company, also of Matawan.

John A. Stierstorfer has been appointed Senior Synthetic Enamel Chemist at the Stamford (Conn.) branch of the Atlas Powder Company's Industrial Finishes Department. Mr. Stierstorfer brings to Atlas a background of a dozen years in the development laboratories of eastern and midwestern paint manufacturers. He completed his studies at Pratt Institute, Brooklyn, N. Y., and began his career with a paint manufacturer in that city.

John G. Wild, specialist for the past twelve years in field engineering of synthetic resin coatings, has been appointed Assistant Sales Manager of Pruf-coat Laboratories, Inc., of Cambridge, Mass., manufacturers of special protective coatings.

Murray

RobertLindley Murray has been elected a Director of Detrex Corporation, Detroit, Mich. He is also Executive Vice-President and a Director of Hooker-Electrochemical Company, Niagara Falls, N. Y.; Vice-President and Director of Hooker-Detrex, Inc., a jointly owned subsidiary of the Hooker and Detrex companies; and a Director of the Power City Trust Company of Niagara Falls.

Mr. Murray is a chemical engineer with degrees from Stanford University and a recognized authority in the chlorine and alkali industry. He is the author of many technical papers, and has received medals for his work in the chemical and engineering fields. He operated an explosive plant for the U. S. Government during World War I and served as a special investigator for the Chemical Warfare Service in surveying German plants manufacturing military chemicals before the end of World War II.

Very active in many community welfare projects and clubs, he was National Tennis champion in 1917 and 1918 and now has a keen interest in golf.

E. J. Cremer has been appointed Manager of the Binks Manufacturing Company's new sales and engineering office located in Suite 4202 of the Empire State Building, New York City. This office will serve as Binks' principal headquarters on the Atlantic Seaboard. Mr. Cremer's duties include technical consultation on spray-painting equipment, finishing, or methods.

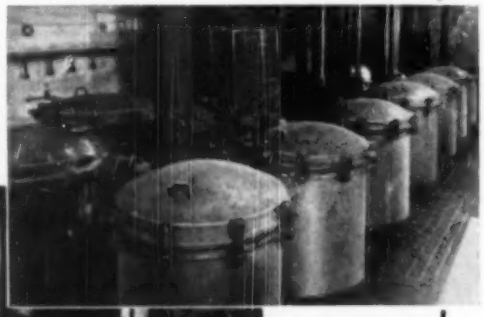
NO SHUT DOWN
to carbon treat solution with . . .
horizontal
SPARKLER *plate* **FILTERS**

SPARKLER horizontal plate FILTERS

Only a few minutes are required to lift out the horizontal plate assembly in a Sparkler Filter and drop in a clean set of filter plates and production is under way without appreciable interruption.

Tanks are given a carbon treatment without shutting down production in the battery installation shown here. One or two filters are cut out of the line, drained, cleaned and dressed with clean filter papers. The proper amount of carbon is mixed with water in a stand-by tank and recirculated through the filters thus depositing the carbon on the plates in a cake of uniform thickness and density. The solution requiring a carbon treatment is then circulated through the carbon beds giving the plating solution the carbon treatment without contaminating the tank or stopping plating operations.

Sparkler Horizontal Plate filters give absolutely sharp filtration at all stages of the cycle.



A battery of 18 Sparkler Filters in one of the largest bright nickel plating plants in the world.

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OBITUARY

✝ **Albert J. Laforet,** 55, salesman for Buckingham Products Company, Detroit, died suddenly on October 17 while on vacation in Washington, D. C.

Mr. Laforet had been with the Buckingham Products Company for more than 12 years, covering the Michigan territory. He leaves a widow and two sons, Albert, Jr. and Henry.

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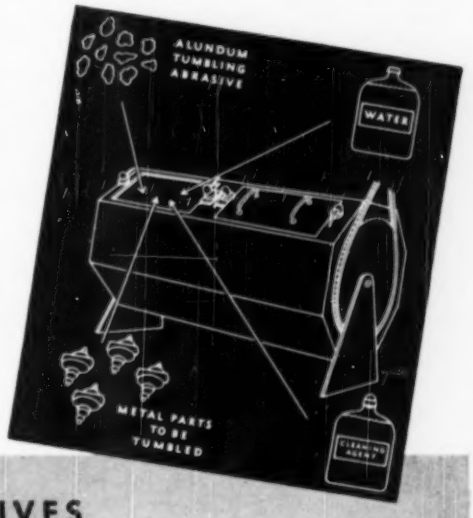
If you're finishing parts like these with expensive, hand-deburring and polishing methods, it will pay you to investigate the precision tumbling process and ALUNDUM Tumbling Abrasive—an ideal tumbling medium. Many progressive plants are using this cost-cutting combination to handle their most difficult finishing jobs.

Now we're prepared to help you test for yourself the advantages of this fast tumbling abrasive and this economical finishing process—without charge or obligation.

If you haven't installed tumbling barrels, and if you aren't familiar with this Norton abrasive product, send us sample parts (unfinished, finished as you'd like them, or required surface finish specifications). We'll tumble the unfinished parts for you—determine the best tumbling cycle—and will furnish you with this worthwhile information, which will help to prove how this product and process can save you time and money.

The chart at the right illustrates the basic elements included in this modern finishing process. If you'd like further details, send for a free copy of the Norton booklet, "Precision Tumbling with ALUNDUM Abrasive," or contact your Norton abrasive engineer or distributor.



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The Mailbox

Subject: Rinsing

DEAR SIR:

I have read the articles on rinsing in the August and September issues of PLATING and disagree with Mr. Kushner's basic equations. Mr. Kushner's equation for equilibrium conditions in a rinse tank introduces a factor of tank volume which will certainly affect the length of time it takes to reach equilibrium but has no effect on the equilibrium concentration in the tank.

Using Mr. Kushner's notation, the following is the basic differential equation for conditions at any time in a rinse tank:

$$V\left(\frac{dC_r}{dt}\right) = C_o 4n - C_r(Q + 4n) \quad (1)$$

The term $C_o 4n$, the amount of ion dragged into the rinse tank in ounces per minute.

The term $C_r (Q + 4n)$ represents the amount of ion being removed from the rinse tank in ounces per minute, including the amount flowing out with the rinse water, plus the amount dragged out on the work. This makes the right member of the equation equal to the change in ion content of the rinse tank expressed in ounces per minute which evidently is equal to the left member of the equation, the rate of change of the concentration of the ion in the rinse tanks as expressed by the term $\frac{dC_r}{dt}$ times the volume in the tank V.

If it is necessary to determine the concentration of the rinse at a given time before it reaches equilibrium the above equation may be integrated to give the following:

$$(Q + 4n)\frac{t}{V} = \log_e \frac{1}{1 - \frac{C_r(Q + 4n)}{C_o 4n}} \quad (2)$$

In the modern plating room we are generally concerned with the condition for equilibrium, at which the rate of change of concentration in the rinse tank is zero, and therefore the right member of the first equation becomes zero. Rewriting the resultant equation we have

$$C_o 4n = C_r(Q + 4n)$$

or

$$C_r = \frac{C_o 4n}{Q + 4n} \quad (3)$$

This is a reasonable equation in that it expresses the fact that at equilibrium the ounces-per-minute dragin must be equal to the ounces-per-minute dragout. Mr. Kushner is correct in assuming that

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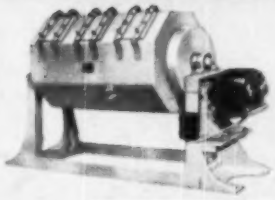
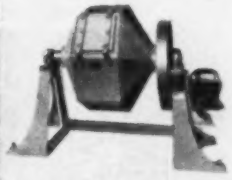
3 - compartment barrel can be used for three different deburring jobs at one time. This model is also available with 1, 2 or 4 compartments.





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The Mailbox

the last term in the denominator, $4n$, can generally be neglected; this gives a simplified equation

$$C_t = C_o \frac{4n}{Q}$$

which contains no term expressing the volume of the tank.

His further analysis of the advisability of using two rinses instead of one to conserve water is very true and too often not fully understood. However, this theory should be presented without confusing the issue by bringing in the size of the tank.

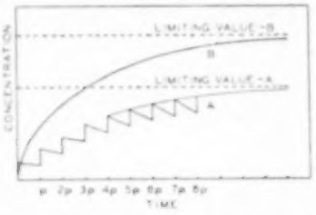
Very truly yours,
NEWELL MCDONALD
Harrison Street
Cheshire, Conn.

DEAR SIR:

Mr. McDonald's letter is one of several communications the writer has received in connection with the paper on "Rinsing". All of them advance the same argument.

The answer is that it is incorrect to assume a differential equation for the rinsing process described by the writer. Only in the case *of continuous* wire and strip plating, where there is *continuous* dragin and dragout, is a differential equation such as proposed, valid. In the cases discussed by the writer, those of rinsing in automatic, semiautomatic and manual plating, the process is a *discontinuous* one, in that work is dipped into the rinse and removed and a *definite period of time elapses* before the next load of work goes into the rinse tank. Such a *discontinuous* process is much more accurately handled by the use of an infinite series as indicated in the article.

The accompanying sketch (which is on an exaggerated scale) gives an idea of what happens in a rinse tank under these



conditions. The concentration of the ion rises in the form of a sawtooth curve from time zero in discreet steps. Between these steps only water enters the rinse tank and the concentration falls in a *smooth curve* because the rinse water is carrying out some of the ion *continuously*. Equilibrium is reached when the almost instantaneous rise in concentration is just equal to the drop in concentration between rinses and the sawtooth curve levels off. The limiting value of this curve, A, is the one described by the author's equation. The assumption of a *continuous* process leads to a curve, B, the limiting value of which may be in serious error. Mr. McDonald's equation (3) gives an equilibrium-concentration value that will approximate that of my equation (14) only if the tank volume is large and p and/or Q are small. Assume C_o = 10 oz/gal, $4n$ = 0.4 gal, Q = 10 gpm, V = 50 gal and p = 1 minute. According to my equation (14), the equilibrium concentration will equal 0.08 oz/gal; according to Mr. McDonald's equation (3) 0.099 oz/gal, an error of about 24 per cent.

Suppose the work is such that a 10-gallon rinse tank (V = 10 gal) will hold it. According to Mr. McDonald the equilibrium concentration in the rinse tank will still be 0.099 oz/gal. The approximation in my equation (14) can no longer be used, instead equation (16), as corrected, should be employed:

$$C_t = \frac{C_o\, 4n}{V}\left(\frac{e^{-pQ/V}}{1 - e^{-pQ/V}}\right)$$

According to this equation the equilibrium concentration is equal to 0.058 oz/gal. The error in the former calculation is now about 70 per cent.

The application of the differential equation to these cases leads to the use of unnecessarily high, wasteful and costly rinse-water flow.

Sincerely,
JOSEPH B. KUSHNER

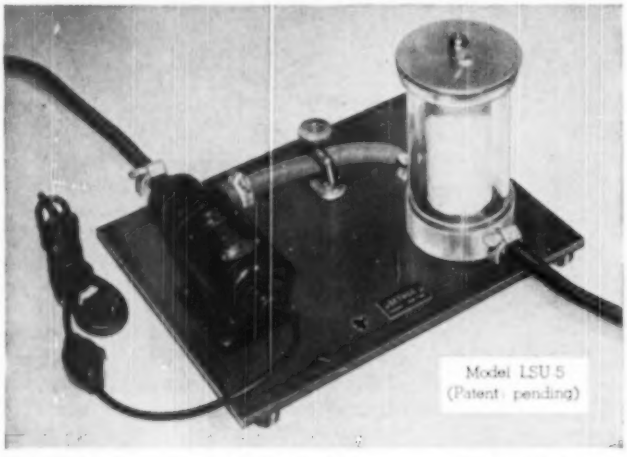
Subject: Water Pollution from Electroplating Operations

DEAR SIR:

I should like to comment on one point

IT'S NEW! IT'S DIFFERENT!

"PINT-SIZED" FILTER FOR "PINT-SIZED" TANKS



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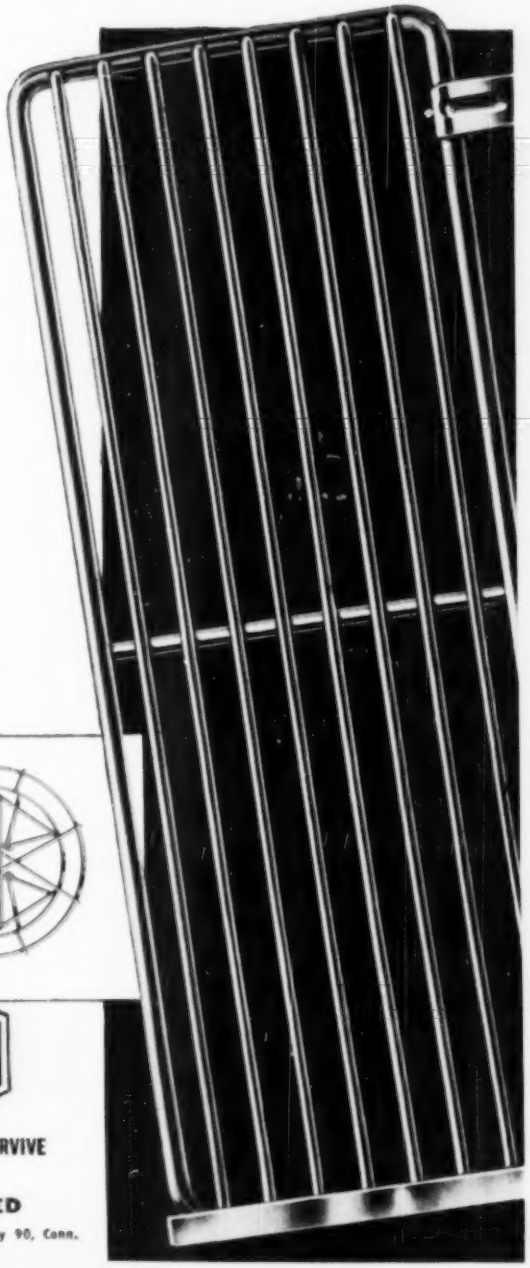
adds chromium-like appearance, multiplies the protection — for only a fraction of a cent per sq. ft.!

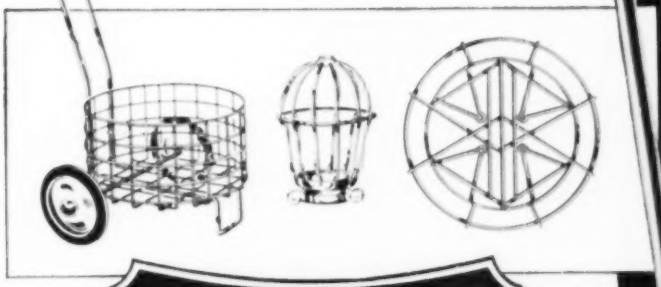


This refrigerator shelf shows what you can do for greater economy in your production. If any wire product needs an attractive finish as well as a serviceable one, it's a refrigerator shelf. Significantly, many of today's well-known manufacturers have shelves zinc plated and finished in Unichrome Clear Dip.* For not only is such a finish outstanding in rust-resistance and brilliance, but it also pares costs without impairing quality!

Unichrome Clear Dip is a chemical treatment which produces an inactive coating which is integral with the zinc. The bluish-bright cast imparted is the image of chromium — and what's more, it *stays* that way!

With costs now under close scrutiny, take a tip from the many companies now using Unichrome Clear Dip to "dress up" wire products — check the quality of this finish and compare the costs. It will pay you. Write us for more data.

*For added protection against abrasion, humidity and food chemicals to which refrigerator shelves are subjected, some manufacturers are now using Unichrome Baking Synthetics over the Clear Dip Finish. The Clear Dip Finish needs no priming.



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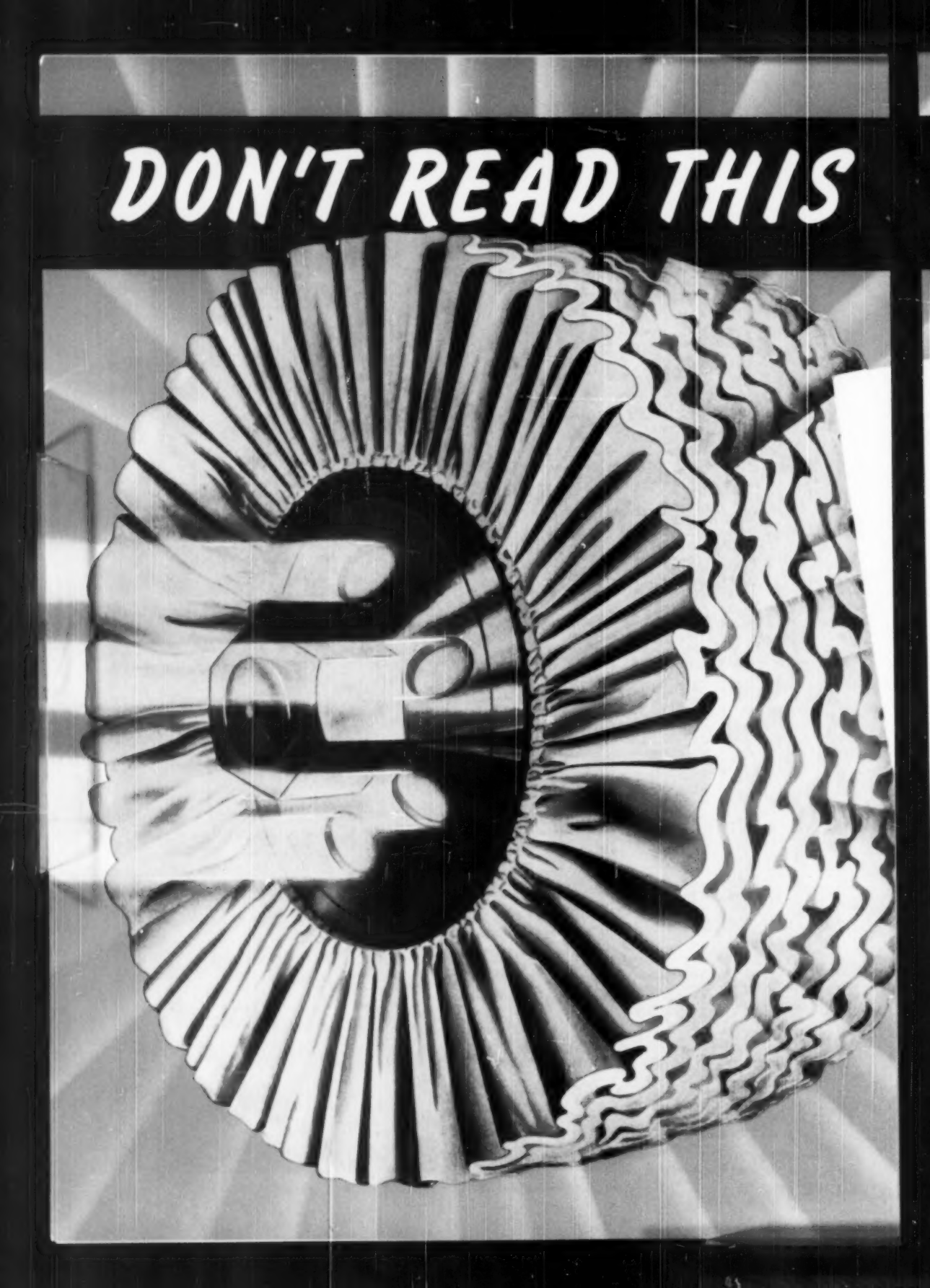
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Yours very truly,

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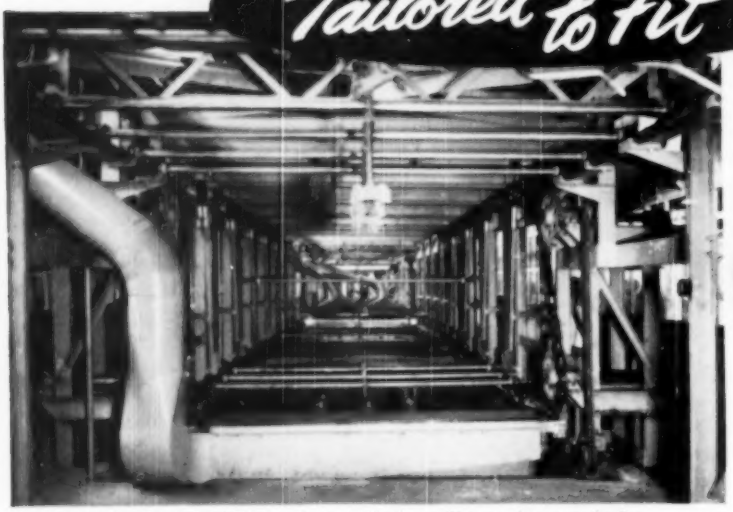
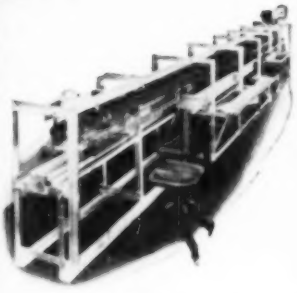
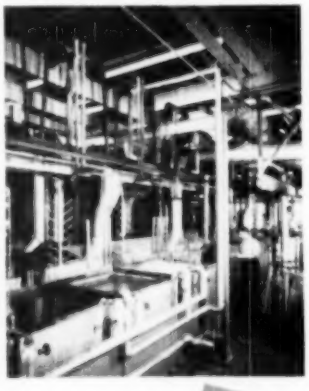


Typical Meaker Straight-A-Way Automatic Machine. This machine was built for copperplating three rows of work simultaneously. It handles 125 racks per hour that are 16 inches wide, 14 inches thick, and 70 inches long.

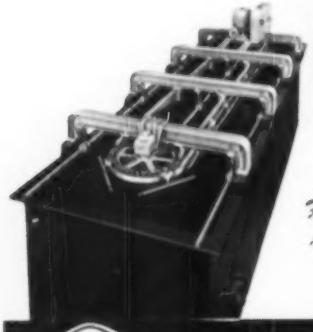


Meaker Special Machine designed for cleaning and silver plating small, brass contact clips. The unit is loaded at one point and the parts are carried through the operating sequence and automatically discharged into a container when completed.

Meaker Return-Type Automatic Machine for chromium plating the large variety of parts in a high-quality line of plumbing hardware.



A Meaker Semi-Automatic Machine for use in medium-output plating departments. This type equipment is used in large job plating plants to supplement the capacity of automatic machines.



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Equipment tailored to fit your requirements, making every operation in the plating sequence automatic, or as mechanized as possible, is the profitable way to handle electroplating on a production basis. This Meaker method applies equally well to departments with only moderate daily output and to the largest and heaviest automatic plating needs of the mass production plants. It offers not only a lower unit cost, but the production is increased, and a better and more uniform quality of product is assured.

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raised in the article by Dr. G. C. Harrold in the September issue of PLATING. This article states, "Neither do we favor use of the method advocated in some quarters in Michigan which involves the collection of all cyanide wastes, their treatment with sulfuric or other acid for liberation of hydrogen cyanide, and the delivery of this gas to the atmosphere through high stacks".

The author does not state why he does not favor this method, but I presume it is because of the possible hazard of poisoning from the liberated hydrogen cyanide gas. While I hold no special brief for this particular process, I think it only fair to point out that hydrogen cyanide is not nearly so deadly a gas as many seem to think. Referring to the review by Mr. Reams and myself in the May issue of PLATING, we presented there some results of the investigations by others in the field of toxicity which shows that hydrogen cyanide is not as toxic as such gases as chlorine, formaldehyde, hydrochloric acid, phosgene, or sulfur dioxide, and no more toxic than carbon disulfide and hydrogen sulfide. One might bear in mind that many stacks from plants burning high-sulfur coals are probably turning out as high, if not higher, concentrations of sulfur dioxide in the flue gases as would be the hydrogen cyanide concentration in the effluent gas properly released from a disposal process of the type in question. Yet I venture to suggest that no one is seriously worried about the hazard from that source.

Another point I wish to make is that it may be possible to eliminate entirely any supposed hazard due to hydrogen cyanide gas by passing the gases from the vats where they are released through a gas or oil burner. The reaction that takes place under such circumstances has not to my knowledge been investigated so I am not sure of the feasibility of this procedure. However, it seems sound and should be worthy of some experimental investigation. We hope to include it in our program of experimental work under Project 10 of the American Electroplaters' Society.

Sincerely,
BARNETT F. DODGE
Professor of Chemical Engineering, Yale University

DEAR SIR:

I do not believe the high-stack method of disposal to be the best for the removal of any industrial waste product. That this attitude is becoming predominant is evidenced by the continued interest of the American public in the development of smoke-abatement codes and of agencies whose sole purpose is to see to it that our atmosphere is kept clean to a reasonable degree consistent with economic facts. With the increasing generation of toxic material by industry, it becomes more

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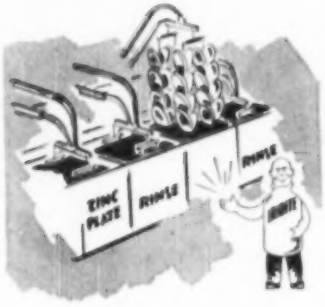
bright finish for

AUTOMATIC ZINC PLATING



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This amazingly low cost protective and brightening process produces a shining stain-free surface with good corrosion resistance . . . utilizing only the normal number of tanks after the zinc plating operation: rinse, Iridite, rinse.

SIMPLE TO OPERATE—NO BLEACHING DIP

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important every day that we remove them so that our air will be fit to breathe. Furthermore, it is becoming increasingly apparent that we have wasted extremely valuable products to the atmosphere which have gone to pollute our property, many of which can now be recovered. For these reasons alone the time will come when the high stacks will be limited either by authority or agreement to a certain number of uses for which other methods are not feasible.

Regarding the toxic properties of hydrogen cyanide, we have had several instances in our own experience when cyanides have acted as poisons under unusual circumstances. Unpublished data of my own indicates that cyanides *from plating operations* can cause, and have caused, toxic symptoms at considerable distances from the actual plating operations because of the stabilization of cyanides under certain circumstances.

As regards the relative toxicity of hydrogen cyanide and other substances it is quite improper to compare gases or vapors which have diverse physiological actions and which vary greatly in their effect at different concentrations.

I would like to refer to Table 3, pages 621-622 of "Analytical Chemistry of Industrial Poisons, Hazards and Solvents" by M. B. Jacobs (1st ed.): While from 200 to 400 ppm hydrogen cyanide will kill animals in a short time, it takes from 600 to 3,000 ppm hydrogen sulfide, from 1,000 to 3,000 ppm hydrogen chloride, from 400 to 3,000 ppm sulfur dioxide, and from 2,000 to 4,800 ppm carbon disulfide (there is no listing for formaldehyde). Furthermore, the concentration for slight symptoms on several hours' exposure, or the maximum permissible concentration on prolonged exposures, varies considerably with circumstances, many of the gases quoted in Dr. Dodge's comments require considerably higher concentrations than does hydrogen cyanide to cause any demonstrable effects. Finally, not noted in this reference but shown in others, hydrochloric acid in a mist form is approximately one-tenth as toxic as the dry hydrogen chloride which is not usually found in plating operations.

We do not mean to infer that we accept all the values in this table; our own experience has indicated otherwise in some instances, but we do wish to point out that it is not correct to say that hydrogen cyanide is less toxic than other materials unless the exact circumstances, including the concentrations, are designated. Furthermore, some of these gases act as irritants and for that reason can hardly cause serious toxic manifestations unless the individual is trapped or held in a confined space; normally the individual will remove himself from the scene immediately. This is not true of hydrogen cyanide which gives very little warning of its presence. This warning factor is given much weight by industrial hygienists in their consideration of air pollution and health protection.

As regards Dr. Dodge's comment about the use of stacks by plants burning high-sulfur coals, I wish to state that I for one am very seriously interested in the emission of sulfur dioxide from combustion processes utilizing not only high-sulfur coals but also high-sulfur oils and other sulfur-containing materials. That I am not the only one so concerned is evidenced by the general discussion of the role of sulfur oxides in the Meuse Valley disaster in Belgium some years ago and the present interest in the Donora situation and the Los Angeles "smog" situation. A number of my own clients have had occasion to be concerned with sulfur dioxide as being destructive to vegetation, paint, and other property. In British Columbia, in the "Trail" case, one smelter paid several million dollars for the privilege of disposing of sulfur dioxide through high stacks. I really do not think it possible to dismiss sulfur dioxide so lightly, even though I, personally, would not put it in a class with hydrogen cyanide for reasons too numerous to state at this time.

As regards Dr. Dodge's final paragraph, I am in complete agreement that it is possible by proper methods of disposal to eliminate entirely any hazard, real or imagined, due to hydrogen cyanide gases or compounds thereof passing to the atmosphere. While I do not know that all the chemical byproducts of large-scale burning of such gases have been investigated, I do know that it has been done on a laboratory scale and that it was suggested as a practical method several years ago. In addition, relatively recent developments in fields of atomization of liquids should make it relatively easy to use waste oxidizing solutions in the destruction of cyanide wastes.

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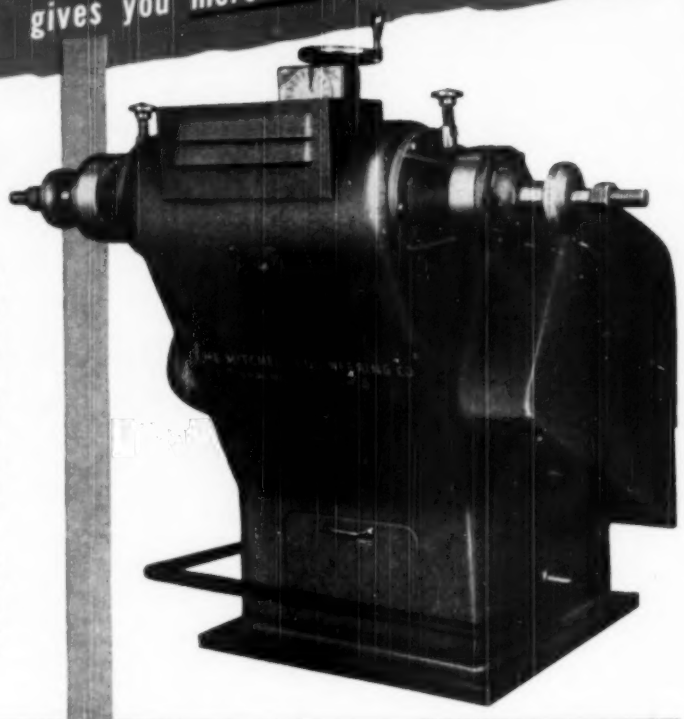

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The cover picture belongs to the story on page 1228 dealing with airplane propeller production. It shows how one of the propeller hub parts is cleaned prior to plating.

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plating

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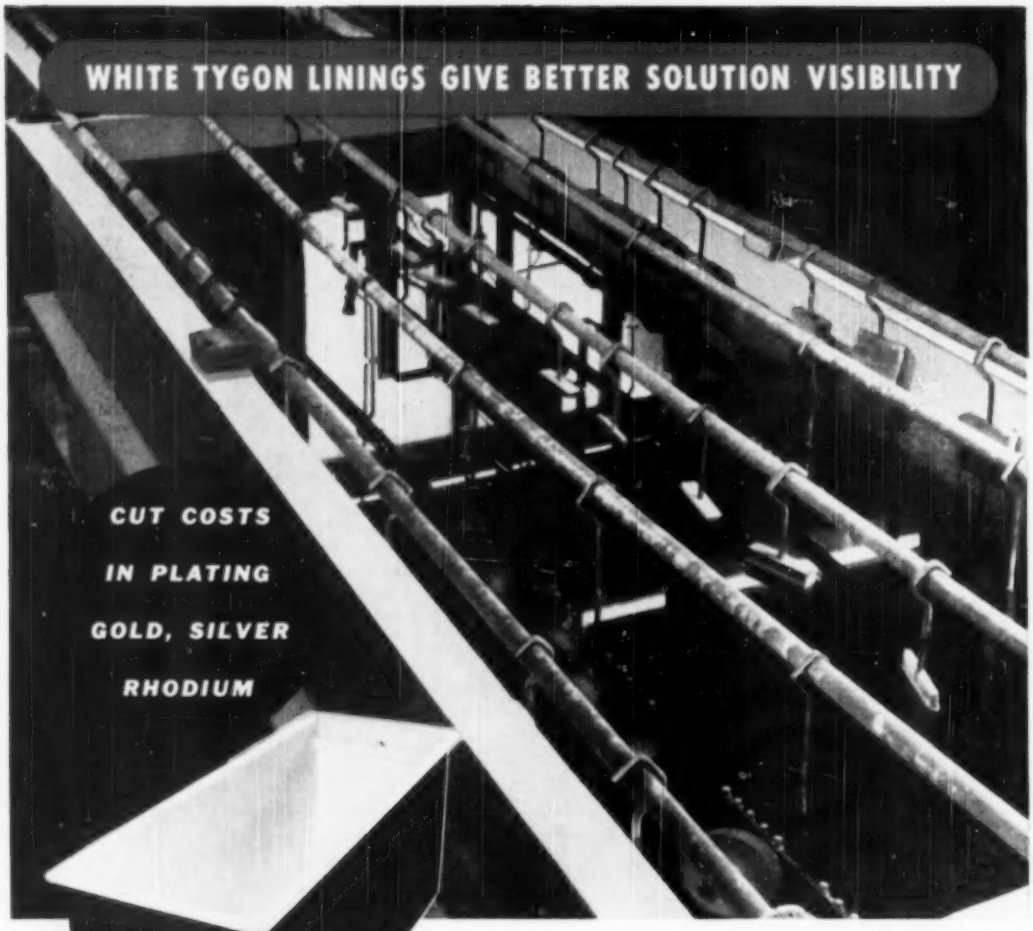

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Editorial

"What's in a name?"

WHILE "That which we call a rose by any other name would smell as sweet", differing vocabularies lead to much confusion.

An old mathematics professor of ours often said that nothing was as beautiful as science, especially mathematics. That may be an exaggeration, but certainly one of the beauties of science is that it has an international language so that the same or almost the same scientific word is used in every civilized country to denote the same concept. A great deal of effort is spent on maintaining this happy state through international commissions. It has been made easier by the convention of basing scientific words on the Latin language and on the names of inventors and discoverers.

Many times one would wish for a similar situation in the plating field. Except for purely chemical and electrochemical terms inherited from the scientists, there is much confusion in terminology. The jewelry plating industry, the ordinary plating industry, and the electrotyping industry all use different words for the same thing even in this country. Recently a member of the Electrodepositors' Technical Society complained that there was a difference in the meaning of polishing terms as used in Sheffield and in Birmingham. There are large variations in usage from one English-speaking country to another.

The situation is, of course, easily explained. Plating has developed as an art, and for many years there was little exchange of ideas even from one shop to another, not to speak of from one branch of plating or one country to another. Thus platers' languages separated like national languages and grew largely from the adoption of what were originally local slang terms.

One may well question if the time has not come to stop and reverse this trend. Naturally it cannot be done at once; nobody can be forced to change his habits. But if agreement on best usage could be established and accepted by journals publishing papers and articles about plating, it would take less than a generation to straighten out this very real difficulty.

Gustaf Soderberg

- new installations
- poor adhesion
- pitting
- roughness
- streaks, blotchy areas
- poor corrosion resistance

TROUBLE SHOOTING in the plating room

RICHARD B. SALTONSTALL

Technical Director, The Udylite Corporation, Detroit, Michigan

TROUBLE SHOOTING in plating presents quite different problems today than it did a number of years ago. No longer are generators used that are so unstable in their electrical characteristics that they reverse their polarity with no apparent reason. The other auxiliary equipment found in the plating room—pumps, motors, filters, agitators, rheostats, temperature controls, water deionizers, plating barrels, semiautomatic and fullautomatic conveyor machines—have over the years been improved to the point that they seldom give trouble provided they are properly used and taken care of. Many proven proprietary processes are now furnished by a number of suppliers, with details regarding the operation and formulation made available to users. Chemicals for preparing processing solutions and metals for anodes are of high purity. Good cleaning compounds and organic solvents are at hand for a wide variety of jobs and for use in several types of equipment such as soak and electrocleaning tanks, spray-washing machines, tumble cleaners and various degreaser combinations. Modern welded steel tanks with inert nonmetallic linings have gone far in preventing solution contamination and stray currents.

Taking all these factors into consideration one might think that there should be no troubles and hence no need for trouble shooting. However, such is not the case; other factors have complicated the picture. Higher quality is continually being demanded. This involves use of heavier coatings, which are always more difficult to plate than thin coatings. Economics and competition require faster plating, and there is always the controversy of cost vs. finish or brightness to trouble the plater.

Quality of base metals is usually poor in a period of shortages and this at times creates additional problems for the plater. Lack of knowledge or interest on the part of designers regarding the inherent limitations of plating processes makes the plater's job more difficult and often increases finishing costs unnecessarily.

Difficulties in New Installations

It is not possible in this article to discuss in detail each problem which may arise, and all its possible causes. Trouble is often experienced when starting up a new hand-line or automatic-machine cycle, especially when sample parts have not been available when the equipment was designed. The only sure way to determine the best method of racking each part is the famous "cut-and-try" method. It is almost beyond human ability to provide for each contingency which may arise after operations have commenced. For example, one operator prepared a cyanide copper solution very carefully, following printed instructions. When all was ready, a rack of work was placed in the tank and nothing happened but gas evolution at the surface of the work. A hurried telephone call to the supplier resulted in the logical answer that the power source was connected backwards. Careful checking, both by tracing the leads and by reversing the connections proved this answer to be incorrect—still only gassing. But investigation of the materials used in making up the solution revealed that powdered pumice had been used instead of copper cyanide. This is, of course, an extreme case, and the solution of most starting troubles is not so simple.

Occasionally a number of things go wrong simul-

taneously and considerable time and patience are required to get production running smoothly. For example, a fullautomatic machine designed for copper-nickel-chromium plating on zinc-base diecastings can present a very troublesome and puzzling combination of problems. It might turn out a few hundred racks of excellent work the first time it is put into operation, and then—trouble! On one such occasion with which the author is familiar the following took place: The diecastings were from new dies and many of them were not of plating quality. The polishing and buffing was poor and no provision was made for inspection of the castings prior to plating. The racking was satisfactory for copper and nickel but had to be changed for chromium. All ventilating ducts led to a common duct and spray from the chromium tank condensed and ran back into the other solutions. The rack fingers had to be bent to change the position of some of the work and in the bending the rack coatings were damaged in such a way that the damage was not detected. This resulted in a second and unobserved source of chromium contamination which continued to cause trouble after the first source had been eliminated. On top of all this, one item which was an appreciable part of the total production was so designed as to be extremely difficult to plate even in a hand-operated line. One can easily imagine the results of such a combination of factors, especially when the assembly line of a motor-car manufacturer was practically shut down for lack of the most difficult part. Bare zinc showed in deep recesses, bare copper in recesses not so deep, and there were pitting, roughness, blistering, mischromes and chrome burning. One difficulty after another would be corrected but the benefits were almost completely camouflaged by those still existing. Only by the persistent efforts of several thoroughly experienced plating men over a considerable period of time were all the faults eliminated and satisfactory work produced. This, of course, is another extreme case, which fortunately does not occur very frequently.

However, since most readers are not often called upon to start up new operations, the balance of this article will be devoted to a discussion of troubles which may occur in established operations and of various method of diagnosing and eliminating their causes.

Poor Adhesion

Probably the most serious fault commonly encountered is blistering, peeling, or in extreme cases misplating or "skipping" in recessed areas, because when it takes place, there is no choice but to strip and rework or discard the object on which the defect has occurred. The first point to establish in the case of composite coatings is where the faulty bond appears and whether it is general or local. Is the entire plate peeling from the base metal? Does the surface of the base metal come away with the plate as sometimes happens with zinc diecastings? Is nickel peeling off copper or off itself? These questions can be satisfactorily answered by a careful examination of the defect. If the faulty bond is between the base metal and the plate, it is logical to look for cleaning trouble and to consider a change in the treatment or composition of the base metal before it reaches the plating cycle. If the condition is general on all or most of the work, it is advisable to stop operations until the situation has been remedied. In such cases, the trouble is usually easier to locate than when the defect occurs only occasionally.

A good way to check on the cleaning is to hand scrub a few pieces with a stiff brush and pumice, then introduce them directly into the first plating solution, bypassing the preparatory cycle. If satisfactory adhesion is obtained, surfaces of acid dips and rinses in the preparatory cycle should be checked for grease or oil, and the cleaners strengthened or changed. If adhesion is poor on the hand-cleaned work, or if misplating persists, contamination of one or more of the plating solutions is indicated and they should be tested by means of small-scale beaker or Hull Cell tests in the laboratory for possible need for purification.

It should be remembered that a wide variety of alloy steels are being used today, containing varying quantities of alloying metals. As the content of chromium, nickel and molybdenum increases, good bond becomes increasingly difficult to obtain; and in the case of stainless steels a low-*p*H nickel strike must be used on the base metal before good bond of other plated metals can be secured.

In the case of zinc-base diecastings,the plate sometimes peels off and a layer of zinc comes with it. This can be caused by cold dies. The first metal which enters the die solidifies quickly, is kept solid by the cold die and does not fuse into the metal making up the bulk of the casting. At times deeper acid etching will compensate for such conditions if the poorly adherent skin is not too thick, but the difficulty should be corrected in the diecasting room.

If nickel is peeling from unbuffed copper, insufficient rinsing (or cleaning in the case of some bright coppers) may be responsible. Sometimes in a severe adhesion test the copper deposit "splits", i. e., is visible both on the back of the peeled plate and on the base metal underneath. This is not necessarily a fault of the copper deposit, but may have taken place simply because something had to give and the copper had the lower tensile of the three materials. There is a pronounced tendency today to substitute a low-*p*H nickel strike for the copper strike on steel which eliminates the "split copper" problem. Present practice is to go directly from the nickel strike into the nickel plating bath without intermediate rinse or acid dip.

This change, however, does not necessarily solve all bond problems. Plating nickel on nickel, while it has been done successfully in production for a number of years, is rightfully thought by many to be a rather touchy operation. The transfer should be made very quickly to a "live" work rod or the work should enter the nickel plating tank with "live" contact if the operation is to be completely successful. This also applies

to a lesser extent when bright nickel is plated on copper and other metals.

When peeling results between the nickel strike coating and the nickel plate it is usually severe. Sometimes the nickel plate itself is laminated and a portion of the deposit peels off when chromium plated. The cause is almost without exception electrical: either contact has been broken for an appreciable period of time, or intermediate electrode effects are present. An occasional failure of this type is most annoying and is often difficult to correct. In one case it occurred in one of two semiautomatics operating side by side on the same type of work from the same cleaning line. In desperation, the operator interchanged the solutions, but the defect persisted in the same machine as before. It could be duplicated at will by lifting a rack off the cathode rail for 10 seconds, but it was impossible to catch a rack breaking contact. The trouble finally disappeared—we never knew why.

One frequent cause of peeling on reworked parts is failure to remove all the nickel before replating. The use of the nickel strike is very helpful in such cases.

Aside from faulty cleaning, probably the most common cause of blistering, peeling, or skipping is contamination of cleaners, acids, rinses, and plating solutions with chromic acid. Where danger of such contamination exists, it is wise to make regular small additions of sodium hydrosulfite to all alkaline solutions, and sodium bisulfite to the nickel when necessary. Excesses of the latter will cause dullness in some bright nickels.

The judicious use of suitable wetting agents in processing solutions can be helpful, but their promiscuous use can do much more harm than good.

Pitting

Pitting, the second major defect, is a rather complex phenomenon and is almost as serious as peeling or blistering, since plate which is appreciably pitted is not acceptable and must be removed if the plated object is to be salvaged. It is often difficult to distinguish pitting from roughness, but this can usually be accomplished by careful examination at various angles to the surface under good magnification. Pitting may be defined, for the purpose of this discussion, as small indentations in the deposit visible to the naked eye which may or may not be associated with similar indentations in the base metal.

"Gas pitting" is one type which was very troublesome in nickel solutions before wetting agents were employed to prevent it. For a few years, it was heard of only occasionally, but now it is being encountered again, principally in high-efficiency alkaline solutions. Gas pits are usually recognized quite easily by the "tails" which project vertically upward or in the direction of agitation. Frequently small bright circular areas surround such pits. These pits appear to be caused by an adhering hydrogen bubble, or by a stream of hydrogen bubbles coming from a focal point, which prevents local deposition of metal. Clean solutions tend to pit less than dirty ones, but this is only part of the story. Wetting agents are being used in some alkaline plating solutions and do a creditable job of preventing gas pits, but their use has its disadvantages. Sometimes the addition of a small quantity of sodium cyanide to lower the cathode efficiency slightly will correct the gas pitting, or the addition of an organic material other than a wetting agent will change the polarization characteristics in such a way that pitting stops. Air agitation is helpful in preventing gas pitting when its use is not objectionable for other reasons.

Another type of pitting, encountered in bright nickel solutions, is called "grease etching". This may occur in localized areas at various current densities and when observed under magnification appears to be a mass of small irregular indentations in the surface of the plate, sometimes extending to the base metal. Increasing the wetting-agent concentration to a value higher than normal will frequently overcome this type of pitting, but the relief is usually only temporary and the bath must be purified to remove the cause of the defect.

Still another type of pitting seen occasionally in bright nickel solutions containing wetting agents has been classified as "foam pitting". This highly objectionable phenomenon occurs on the under side of surfaces which are horizontal or nearly so. It is caused by pumps sucking air into the solution at leaky packing glands or other leaks in the suction line. This air is dispersed by the pump impeller into many tiny bubbles which are partially stabilized by the wetting agent. These tiny bubbles tend to rise in the solution and seem to come up against horizontal surfaces faster than they can escape around its edges. The result varies from black pits to large black wormy-looking areas. The obvious remedy is to prevent air from being sucked into the pump.

Pits in base-metal surfaces are often mistaken for pits caused by faulty plating. A good bright-plating solution will tend to minimize or hide small imperfections such as polishing lines, but when the base metal is pitted the bright plates tend to accentuate the pits as far as appearance is concerned. A case in point recently occurred in a shop where grille sections of fair-quality cold-rolled steel were being prepared for bright nickel plating by only a single wheel operation on a sisalin buff. The plated finish passed inspection for some time, then all of a sudden the plate was not bright enough. Careful examination showed that the surface of the steel from a new lot was more deeply pitted than previously and that the sisalin buffing operation no longer was sufficient to eliminate the pits, which were very fine and close together.

Another example of base-metal pits is cold-shot areas in diecastings. A certain large casting was giving much trouble, always in the same location on the casting. The pitting was so bad that black streaks, characteristic of zinc, were emanating from the pits. By increasing the thickness of the copper strike coat-

ing prior to bright copper plating it was possible to hide the defect almost completely, although it is probable that this area would still be vulnerable to corrosion. The real remedy, of course, would be to improve the casting.

Roughness

A third major fault which at some time or another plagues most plating operations is roughness of deposits. From a visual standpoint, this is more serious now that so much bright plating is used than earlier when many electrodeposits were heavily buffed to brighten them. From the standpoint of corrosion resistance, roughness is always detrimental. If the plate is buffed to eliminate the roughness, particles are almost certain to be torn out, greatly reducing resistance to corrosion and often creating a pitted appearance.

Roughness, like pitting, may be so fine and widely distributed as to be confused with lack of brightness.

Causes of roughness may be divided into two general classifications—those existing on the work when it is placed in the plating bath, and those existing in the plating bath itself. Both may be present at the same time, which makes the problem more confusing. A good preliminary test to locate the source of the roughness is to apply a heavy copper plate to a few pieces, buff them, and introduce them at various positions in the cycle.

One of the most common causes of roughness when plating on steel is faulty polishing. On many occasions the addition of a single operation with finer emery and grease stick or with a tampico wheel makes the difference between severe roughness and acceptably smooth work. To perform the final polishing operation with a dry wheel is to invite roughness. Slivers of steel adhere to the work, which is usually more or less magnetic, and act as starting points for nodules. When these nodules are removed by buffing, they are either torn out, or cut down so that the end of the steel sliver is exposed, and in either case rusting may begin very soon.

Insufficient cleaning may also cause roughness. A striking example was the elimination of roughness by the addition of an anodic cleaner immediately prior to the spray washer. This roughness had been so severe that a heavy sisalin buffing operation on a semiautomatic lathe had been necessary to remove it, undoubtedly at a tremendous sacrifice of corrosion resistance.

Removal of soluble polishing and buffing compounds by means of a vapor degreaser can leave insoluble solids on buffed brass, copper, or zinc which will result in roughness. The use of a solvent spray will in many cases correct this condition.

Roughness which occurs in the plating solutions themselves may be divided into two types—settling roughness which occurs on horizontal surfaces or nearly horizontal surfaces facing upward, and general roughness which occurs on any or all surfaces regardless of their position.

The first type, settling roughness, is usually not difficult to cope with. It is caused by the presence of solid particles in the solution, which under the influence of gravity settle on the work and become included in the plate. A good batch filtration, or in many cases continuous filtration, will correct the trouble by removing the particles, provided they do not enter the solution or form too rapidly. The source of these particles is often difficult to find. Faulty anode corrosion and attendant sludging is one source. In cyanide solutions this can often be corrected by adjusting the anode current density, provided the anodes are of satisfactory purity. Bags can be used in acid solutions, but fine metallic particles can get through bags. Bags cause trouble in alkaline solutions, and quite recently there has been much interest in building semipermeable diaphragms for anodes in bright copper solutions which have caused considerable roughness troubles. There is almost always some sludge on the bottom of a plating tank, and if the solution is stirred to the bottom, intentionally or accidentally, this sludge will cause settling roughness. Iron precipitated as ferric hydroxide in the solution or falling into the solution as rust from overhead structures is another source. Powdered metal from incorrectly designed sliding contacts on an automatic machine has caused baffling cases of roughness. Any solids falling into the plating solution from the air can cause not only roughness but chemical contamination; hence the practice of separating plating from unavoidably dusty polishing operations.

Calcium sulfate has the peculiar property of becoming less soluble as the temperature is increased. Thus, if a sulfate solution is treated with lime and filtered at a low temperature, calcium sulfate will precipitate when the temperature is raised. Depending on particle size, either settling or general roughness may result.

Two rather obvious causes of roughness are leaky filter diaphragms and anode bags with holes in them.

A less common source is the formation of nickel hydrate in the bath caused by burning on unoccupied rack contacts. When burning on high-current-density areas of work forms rough areas, faulty solution balance or too high a current density is indicated. Certain impurities in plating solutions such as carbonates in copper and phosphates in nickel baths may cause burning and rough deposits at normally safe current densities.

Pigmented rack coatings may disintegrate slowly and the pigment slough off in the plating solution.

Steel parts may be magnetized in polishing operations or under the influence of direct-current fields in plating. Even though adhering metallic slivers have been removed, such magnetic parts will attract magnetic particles in the plating solution and roughness results. Bumper bars which were apparently nonmagnetic when they entered the plating cycle have come out so strongly magnetic that they would cause an open pocket knife balanced on the finger to dip sharply

when the knife blade was brought close to the bumper. Bags were not being used on rather poor cast nickel anodes and, needless to say, the plate was exceedingly rough.

There are probably other possible causes of roughness but those discussed are believed to be the most common.

Streaks and Blotchy Areas

A fourth major defect which is peculiar to bright plating is streaking and irregular blotchy areas which are less bright than the surrounding area. The tendency is always to attribute this defect to a faulty condition of the bright-plating solution, but there may be other causes.

In fullautomatic and hoist-operated cycles, where the transfer time is usually longer than in hand-operated cycles, there is always a tendency for hot cleaners to dry on the work before the transfer into the subsequent rinse tank is completed. The presence of wetting agents in cleaners may aggravate this condition since drainage is better and the thinner film of alkali will dry more quickly. The exact outline of bubbles from dried cleaner foam may appear on the finished work. Elimination of wetting agents, lowering of cleaner temperature, and use of mist sprays to keep the work wet in transfer will usually solve such problems.

Some bright cold-rolled steels which are formed into shapes and bright plated without polishing have organic materials rolled into the surface and are extremely difficult to clean. Failure to remove these organics can cause unevenness in brightness. There is no general remedy for this condition. Sometimes degreasing prior to the usual cleaning will solve the problem. In unusually stubborn cases it is necessary to tumble the parts wet with a fine abrasive. Insufficient cleaning is frequently the cause for such defects. Pickling is retarded on unclean areas, and this may cause splotchy bright plate. Over-pickling and failure to remove smut causes dullness which is really fine roughness.

However, clouds, streaks, and lack of uniformity of brightness are in many cases caused by solutions being out of balance or contaminated, and then small-scale beaker or Hull Cell tests will usually duplicate the difficulty.

White areas in chromium plate are easily caused by intermediate-electrode effects, and general whiteness by broken electrical contact.

Poor Corrosion Resistance

The last common fault to be discussed is poor corrosion resistance. Corrosion-resistance requirements in most plating specifications for cathodic coatings are based on thickness and salt-spray resistance—not one or the other, but both. The importance of this in specification plating cannot be overemphasized. While correlation between salt-spray hours and various conditions of atmospheric exposure has not been established, the salt-spray test will pick out unsatisfactory deposits. In other words, coatings which fail in the salt spray will very probably fail in service, but coatings which meet salt-spray specifications will not necessarily stand up well in service.

A specification which requires 0.001 inch of nickel and 100 hours salt spray does not gurantee that 0.001 inch of nickel will withstand the salt-spray test for 100 hours without breakdown. On a given base metal it may be necessary to deposit twice or several times the specified thickness of nickel to meet the salt-spray requirement. Recent results of A. E. S. Research Project No. 5 indicate that the presence of as little as 50 mg/l of copper in the nickel bath can cut salt-spray life in half. This should be confirmed by further experience.

Much difficulty is being experienced today in meeting salt-spray specifications on nickel plated steel. Some attribute this to poor quality of plate from proprietary solutions, others to poor quality of base metals, and others to occlusions and impurities in the plate. Certainly any one of these factors, or even worse, a combination of two or more, will mitigate against satisfactory resistance to corrosion.

However, data based on surveys made by a large motorcar manufacturer indicate that in spite of the handicaps we are progressing in the right direction. The quality of bright plate on automobiles is definitely better now than ever before.

The previous remarks refer principally to cathodic coatings. In the case of cadmium and zinc, which are anodic to steel, the purpose of the salt-spray test, when used, is to check for bare areas or areas of thin plate.

Some readers are familiar with the atmospheric-exposure tests of copper-nickel-chromium and nickel-chromium coatings on high-carbon steel now in progress under the auspices of Committee B-8 of American Society for Testing Materials. A recent unofficial interpretation of the data so far collected reveals two rather striking facts. Assuming good steel, well polished and cleaned, the corrosion protection is dependent principally on (1) the thickness of nickel (whether or not copper is used as an undercoat) and (2) the type of atmosphere to which the coatings are exposed. This data in the opinion of the author shows quite conclusively that copper cannot be substituted for nickel. The performance of the so-called "Victory" plate on automotive bumpers early in the War also indicated this fact.

There have been some failures caused by cracking of nickel-chromium deposits. It is a known fact that bright nickel plate is not as ductile as white nickel plated from a good Watts-type bath, and may not be sufficiently ductile at present to meet all requirements; but progress is also being made in this respect. While fully bright nickel may never equal white nickel in ductility, recent developments have progressed sufficiently that one may anticipate appreciable improvement in the near future.

THE STRENGTH AND DUCTILITY OF ELECTRODEPOSITED METALS

I. The Hydraulic Bulge Test *

THOMAS A. PRATER†
AND HAROLD J. READ‡

This article treats a subject which has become increasingly important in the choice not only of plated coatings for mechanical purposes or for electroforms but also of decorative coatings and processes.

The description of the test method published here will be followed by installments giving results of tests.

Introduction

Several recent publications[1,2,3,4] are indicative of the current interest in the determination of the mechanical properties of electrodeposited metals. It is rather remarkable how little is known of these properties when one considers the long period of time during which plated metallic coatings have been in common and widespread use. Of the various mechanical properties which may be determined for metals, tensile strength, ductility and hardness are, perhaps, the most useful from the engineering viewpoint. The hardness of electrodeposits may be measured quite easily with equipment which is readily available, and the determination of this property is not so badly in need of attention as are methods for measuring strength and ductility.

Such measurements of strength and ductility as are presently to be found in the literature have been made on sheet tensile specimens or tubes which were pulled in simple tension. Almost without exception the deposits have been much thicker than those commonly used for decorative or protective coatings or both. There are serious objections in many cases to the use of thick deposits since it is well known that the character of the deposit, particularly with respect to grain size and structure, varies markedly with increase in thickness. The work of Brenner and Jennings[3], for instance, indicates that thickness has a profound effect on the properties of electrodeposited nickel. There is, therefore, no assurance that measurements on a thick deposit will be even approximately valid for thin deposits. It is not even desirable to use thick deposits to compare several deposits on a qualitative basis since the variations caused by thickness may not be comparable in the specimens.

At once the inquiry arises, why not use thinner specimens? The answer is simply that it is not very practical to use ordinary sheet tensile testing methods on specimens which range from a fraction of a mil to only a few mils in thickness (in this paper 0.001 inch (0.025 mm) will be consistently referred to as a mil). Some of the difficulties are set forth in the following paragraphs.

(a) Specimen Preparation.—The usual sheet tensile specimen must be cut or machined to rather accurate dimensions. Although this operation can be carried out on very thin materials either by stamping with a die (such as is used in preparing rubber tensile specimens) or by machining the specimens whilst they are

* It is anticipated that the material presented herein and in succeeding papers will be incorporated into a thesis to be submitted by Thomas A. Prater in partial fulfillment of the requirements of the degree of Doctor of Philosophy in Metallurgy.

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clamped between heavy supporting dummy blocks, special equipment or expensive labor or both are required.

(b) Specimen Grips.—The grips available for standard testing machines are not adapted to the holding of very thin specimens. Special grips which will hold the specimens can and have been designed, but they are so bulky and unwieldy that it is difficult to mount the specimens in them without distortion.

(c) Alignment.—In order to obtain satisfactory results in the tensile test, particularly with brittle materials (and many electrodeposits fall in this category), axiality of loading is highly important. The authors are not familiar with any method of checking axiality of loading which could be applied to specimens even as thick as 5 mils, much less thinner specimens.

(d) Measurement of elongation and reduction of area.—The two criteria of ductility which are normally measured in the tensile test are per cent elongation and per cent reduction in area, and of these, reduction in area is generally accepted as being the more important. Elongation is measured after fitting together the broken pieces of the specimen after fracture. The execution of this operation on material which is a mil or a fraction thereof in thickness presents a well-nigh insuperable problem in technique. The authors are not familiar with any means by which reduction in area can be accurately and conveniently measured, or for that matter, even crudely measured.

These matters are sufficient to show that the simple tensile test is fraught with difficulties so far as thin materials are concerned. Doubtless many of them could be overcome if necessary, but fortunately there is another test which will yield the desired information. This is the hydraulic bulge test.

In 1930 Jovignot[6], in an effort to improve the bulge test as a means of measuring the ductility of sheet metal, proposed that the hemi-spherical plunger of the familiar Erichsen cup tester be replaced by oil under hydraulic pressure. This arrangement, shown diagramatically in Fig. 1, permits the uniform application of pressure to all parts of the bulge (which is not possible with a solid, metallic plunger) and allows the application of well-known equations relating to the strength of thin shells. It is known[7] that for bulges which have a spherical surface

$$T = \frac{PR}{2t} \qquad (1)$$

where T is the tensile strength, P the pressure at the moment of fracture, R the radius of curvature of the bulge, and t the thickness of the sheet. Of these quantities, P is easily measured and R may be calculated from the height of the bulge. If one is content with nominal tensile strengths, t may be taken as the original thickness of the sheet. For the calculation of true tensile strength the instantaneous thickness at the moment of fracture must be known. It can be readily calculated once the strain distribution in the bulge is

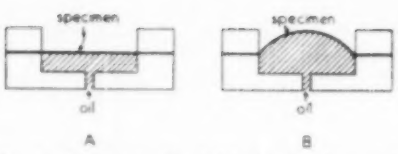

Fig. 1. Diagrammatic sketch showing how a sheet specimen is deformed in the bulge test. The specimen is shown at the start of the test at left and partially deformed at right

ascertained. This point will be considered at some length in a later section of this paper.

It might be well to note here, for the sake of reference, the equation for calculating the radius of curvature of the bulge:

$$R = \frac{r^2 + h^2}{2h} \qquad (2)$$

where r is the radius of the opening through which the bulge is blown and h is the height of the bulge. In Jovignot's work, and in that of others who used his test, the height of the bulge was usually measured with a dial indicator or some other mechanical device. This method is satisfactory for ordinary sheet stock, but for materials a mil or less in thickness the resistance of even a high-quality dial indicator would distort the bulge. The authors have overcome this difficulty by means of a simple optical device which enables the height of the bulge to be measured without any possible distortion caused by the measuring device.

It is evident from the above discussion that tensile strengths may be determined from the bulge test, but what is the situation with respect to ductility? It is evident that the height of the bulge will be the greater, the greater the ductility of the sheet. The mathematical expressions for evaluating the ductility will be postponed for the moment, but it can already be seen that the bulge test shows much promise of yielding interesting and valuable information. It might, however, be well to pause here for a moment and see if this test promises anything in the way of overcoming the several difficulties discussed above in connection with the simple tension test.

(a) Specimen preparation.—All that is required is that a disc be cut from the sample to be tested. This disc need not be accurate either in circularity or diameter; hence, specimen preparation is no problem.

(b) Specimen grips.—These are replaced by clamping rings which are easily and cheaply prepared. It is an simple matter to mount the specimen in the clamping rings.

(c) Alignment.—This problem does not exist in the bulge test.

(d) Measurement of elongation and reduction of area.—Ductility is evaluated in terms of true strain which can be calculated from the height of the bulge once the strain distribution is known.

It is evident at once that an investigation of the bulge is justified so far as experimental technique is concerned.

Fortunately, a rather considerable amount of work has been done in the past few years on the relationship between tensile properties as measured by the bulge test and those determined in the conventional manner.

Interpretation of Bulge Test Data in Terms of Simple Tension

It would be an easy matter to compare the tensile properties of various materials by making only two simple calculations after measuring the deflection of the center of the specimen required to cause fracture. The value of T given in equation (1) could be taken as an indication of the tensile strength. The equation

$$\epsilon = \frac{l_a - l_c}{l_c} \times 100 \qquad (3)$$

where l_a is the length of the great arc of the bulge, and l_c the length of the chord, could be employed as a measure of the per cent elongation. These values, while easily obtained, have two serious disadvantages. First, the strain* is not uniform over the entire specimen, but instead varies from zero at the circumference to a maximum at the center. Second, the ability of a metal to elongate in a given direction is decreased by introducing stresses which cause it to elongate in a second direction. Both objections lead to the same conclusion, namely, that the expression given in equation (3) yields a value of elongation far below that which is truly representative of the ability of the same material to deform in simple tension. General familiarity with the simple tension test makes it desirable to express values of stress and strain, for any type of test, in terms which are not significantly different from those used in describing the results of the simple tension test.

In order to describe the behavior of a material in a hydraulic bulge test in terms similar to those employed in simple tension, it is necessary to introduce the concepts of "true stress" and "true strain". It is customary in constructing a stress-strain curve from data obtained in a simple tension test to calculate the stress at any time by dividing the load by the original cross-sectional area of the specimen. This obviously does not give a true representation of what is taking place during the test, because as the load is increasing, the cross-sectional area is steadily decreasing. The "true stress", σ, is equal to the load divided by the actual cross sectional area at the time the load is noted†.

$$\sigma = \frac{P}{A_i} \qquad (4)$$

where P is the load, and A_i is the instantaneous cross-sectional area.

By similar reasoning we see that the usual method of expressing elongation fails to represent accurately the straining which actually takes place during a tension test. The test specimen elongates continuously as the load is increased; thus, each successive unit increase in length represents a smaller percentage elongation because it is distributed over a longer gage length. "True strain", δ, is defined as follows:

$$\delta = \int_{l_o}^{l} \frac{dl}{l} = \ln \frac{l}{l_o} \qquad (5)$$

where l_o is the original gage length, and l is the length at the time the strain measurement is being made.

Lankford, Low and Gensamer[1] have shown that data obtained in the hydraulic bulge test may be expressed in such a manner that they can be compared with the true stress-true strain relationship of simple tension if generalized functions of stress and strain are employed. The stress systems included in their investigation were simple tension, simple compression, balanced biaxial tension, and unbalanced biaxial tension. Their results indicate that for a given isotropic‡ material one stress-strain curve can be constructed which will represent the behavior of a material for many states of stress if the stress and strain are expressed as generalized functions called "significant stress", $\bar{\sigma}$, and "significant strain", $\bar{\delta}$. These functions are defined as follows[11]:

$$\bar{\sigma} = \left| \tfrac{1}{2}[(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_3 - \sigma_1)^2] \right|^{1/2} (6)$$

$$\bar{\delta} = [\tfrac{2}{3}(\delta^2_1 + \delta^2_2 + \delta^2_3)]^{1/2} \qquad (7)$$

where σ_1, σ_2, and σ_3 are the three principal stresses¶,

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*A strain is the change in form or size of a body produced by a stress. A stress is a force or load per unit area. Thus elongation is a strain, tensile strength a resistance to stress. Editor.

†In this discussion, no effort will be made to derive rigorously the relationships employed. These are in widespread use in the field of Engineering Mechanics and the reader is referred to texts such as Timoshenko[9], Nadai[8], and Marin[10].

‡Isotropic simply means having the same physical properties in every direction. Editor.

¶It has been shown, theoretically and experimentally[7], that no matter how complicated the system of applied loads may be, the stresses in any body can be resolved into three normal and three shear stresses. It has also been shown that there are always three mutually perpendicular planes on which the shear stresses are zero. It is then possible to describe completely the state of stress by giving the orientation of these three planes, and the magnitudes of the normal stresses acting on them. The three mutually perpendicular planes of zero shear stress are called the "principal planes" and the three stresses, normal to these planes, are known as the "principal stresses". In a body subjected to tensile stresses only, it develops that one of the principal stresses lies in the direction of maximum stress, and a second lies in the direction of minimum stress.

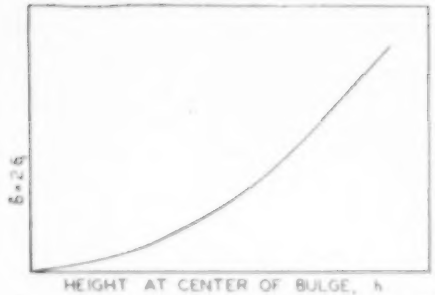

Fig. 2. Typical curve of significant strain at the top of the bulge vs. height of the bulge

and δ_1, δ_2, and δ_3 are the strains in the directions of the principal stresses.

In simple tension, where the stress is in one direction only, that stress will be σ_1, and σ_2 and σ_3 will both be equal to zero. It will be noted that by substitution of these values in equation (6), for simple tension:

$$\bar{\sigma} = \sigma_1 \tag{8}$$

In simple tension δ_1 is the strain parallel to the tension direction and δ_2 and δ_3 are the strains in directions perpendicular to the tension direction. In an isotropic material, δ_2 and δ_3 will be equal and, because the volume of the specimen remains constant, will each be equal to $-\delta_1/2$. If these values are substituted in equation (7) we obtain

$$\bar{\delta} = \delta_1 \tag{9}$$

Thus for simple tension the significant stress–significant strain curve is seen to be identical to the true stress–true strain curve.

In a balanced biaxial stress system such as the hydraulic bulge test, $\sigma_1 = \sigma_2$ and $\sigma_3 = 0$. Under these conditions, from equation (6)

$$\bar{\sigma} = \sigma_1 \tag{10}$$

From equations (1) and (10) we can obtain the following relationship for the bulge test.

$$\bar{\sigma} = \sigma_1 = \frac{PR}{2t_i} \tag{11}$$

where t_i is the instantaneous thickness of the specimen.

Since σ_1 and σ_2 are equal at the top of the bulge, if the material being tested is isotropic,

$$\delta_1 = \delta_2 \tag{12}$$

Because the volume of the specimen can be considered to remain constant during deformation, δ_3 will be opposite in sign, but equal in value to the sum of δ_1 and δ_2.

$$\delta_3 = -(\delta_1 + \delta_2) = -2\delta_1 \tag{13}$$

Substitution of the relationships given in equations (12) and (13) in equation (7) shows that for balanced biaxial loading

$$\bar{\delta} = 2\delta_1 \tag{14}$$

From equations (11) and (14) we note that in order to construct a significant stress–significant strain curve for a specimen deformed in a hydraulic bulge test, it is necessary to make simultaneous readings of P, R, t_i, and δ_1 or of some variables from which these values may be calculated. In practice it is necessary to make simultaneous readings of only the pressure, P, and of the height of the bulge at the center, h. The procedure for obtaining the desired curve from these data will be discussed later.

In a hydraulic bulge test the strain varies from zero at the clamped edge to a maximum at the top of the bulge. It is not possible, therefore, to determine the strain at the top of the bulge by simply measuring the height of the bulge. The strain at the top may be determined from the height of the bulge if the strain distribution is known. The most convenient means of establishing the necessary relationship is to deform a series of specimens to different heights and measure the linear strain, δ_1, at the top of the bulge for each of the several values of h. In the present work a 20-line-per-inch photo-grid[12] was printed on a series of specimens. These were then placed in the bulge tester and deformed various amounts. In each case h was measured before the specimen was removed from the tester. After having been removed from the tester the specimen was placed under a comparator and the distances between the photo-grid lines at the top of the bulge were measured. δ_1 was determined from these measurements by use of equation (5). These data were then plotted as shown in Fig. 2. This curve shows the approximate relationship which exists between δ_1 (or $\bar{\delta}$) and h. It has not been determined as yet whether the strain distribution varies appreciably from one electrodeposited material to another, or if one such curve will be applicable to all materials. It should also be recognized that the curve would be different for specimens of different diameters.

Let us now consider the necessary steps in constructing a significant stress–significant strain curve for a specimen tested to failure in a hydraulic bulge test. It is first necessary to obtain simultaneous readings of pressure, P, and height of bulge, h, at frequent intervals during the deformation of the specimen. Values of the significant strain corresponding to any value of h can be obtained directly from Fig. 2. The calculation of significant stress for any pressure, P, from equation (11) requires that the radius of curvature, R, and the instantaneous thickness of the specimen, t_i, be known. As stated earlier, these values can be calculated if h is known. The relationship between R and h is given in equation (2). It is convenient to prepare a curve of R *vs.* h over the range of h values

likely to be encountered in testing. The corresponding value of R may then be obtained simply by reference to the curve. A typical curve of this type is shown in Fig. 3. It is not possible to express the thickness of the specimen, t_i, as a function of h unless the original thickness of the specimen to be tested is known. However, it is convenient to establish a relationship between the ratio $\frac{t_i}{t_o}$ and h, where t_o is the original thickness of the specimen. If it is known how the ratio $\frac{t_i}{t_o}$ varies with h, one can radily calculate t_i for any height of bulge provided t_o has been measured before the test was started. The relationship between the ratio $\frac{t_i}{t_o}$ and h can be established as follows:

It has already been indicated that in the circular bulge test

$$\delta_2 = -(\delta_1 + \delta_2) = -2\delta_1 \qquad (13)$$

and

$$\bar{\delta} = 2\delta_1 \qquad (14)$$

It is then obvious that

$$\bar{\delta} = -\delta_2 \qquad (15)$$

and since from equation (5)

$$\delta_2 = \ln \frac{t}{t_o} \qquad (16)$$

we see that

$$\bar{\delta} = \ln \frac{t_o}{t}$$

or

$$\bar{\delta} = 2.3 \log_{10} \frac{t_o}{t} \qquad (17)$$

The value of $\bar{\delta}$ corresponding to any value of h may be obtained from Fig. 2, and the values of $\frac{t_o}{t}$ corresponding to any value of h may be obtained from a curve such as that shown in Fig. 4. Hence, for any value of h we are able to calculate the ratio $\frac{t_i}{t_o}$ from equation (17). If the original thickness of the specimen is known, t_i can be determined at any time during the test.

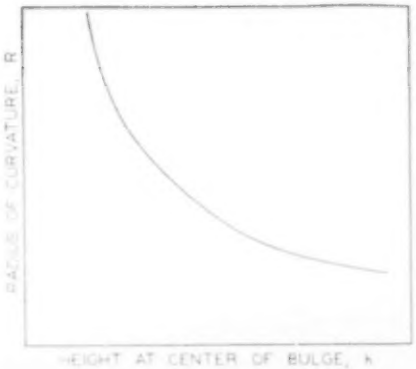

Fig. 3. Typical working curve from which the radius of curvature may be found for a given bulge height

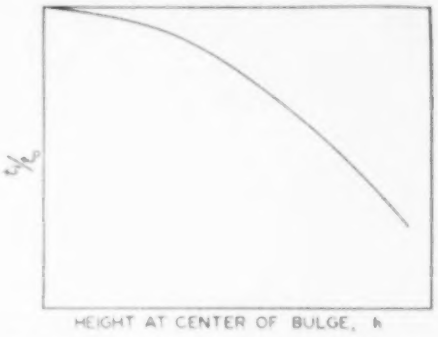

Fig. 4. Typical working curve from which the ratio of the instantaneous thickness, t_i, to the original thickness, t_o, may be determined for a given bulge height

It is now possible to construct a significant stress–significant strain curve for a hydraulic bulge test by obtaining the significant strain directly from a curve such as shown in Fig. 2, and by calculating the significant stress by use of equation (11), employing master curves of the type shown in Figs. 3 and 4 to aid in the calculation.

Experimental Method

The equipment which has been constructed for the testing of electrodeposits is shown in Fig. 5. The steel base plate, A, has been machined to provide a boss which matches the under side of the clamping ring, B, and the specimen is clamped between these two surfaces by means of eight hold-down screws. The inner edge of the ring, B, is rounded to prevent a shearing action as the bulge develops. The inside diameter of the ring is 1.58 inch (38 mm) and a specimen approximately 2.4 inches (61 mm) in diameter is used. In order to avoid bending effects which would influence the results, the ratio of the inside diameter of the clamping ring to the thickness of the specimen should exceed 200. The apparatus may, therefore, be used with perfect safety for material up to 5 or 6 mils in thickness.

Oil is introduced into a shallow chamber under the specimen through a hole in the center of the base plate, A. A hydraulic testing machine is used to provide the oil under pressure, and the fine adjustment of the loading valve on the testing machine gives a delicate control of the rate at which the oil is pumped

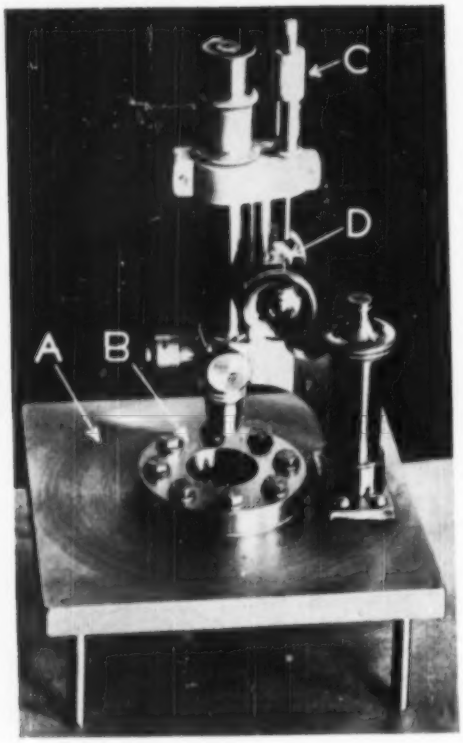

Fig. 5. Photograph of the bulge test apparatus. The components identified with letters are described in the text

into the bulge tester. This, of course, determines the rate at which the bulge will be blown. It is possible, also, to stop the test at any point and then resume operations without appreciable surging. The pressure is measured with a large mercury manometer in the range of 0–25 psi (0–1.6 kg·cm^2) and with calibrated Bourdon gauges for the higher pressure ranges — two gauges with ranges of 0–100 psi (0–7 kg·cm^2) and 0–600 psi (0–42 kg·cm^2) have been found most useful. A device for dead weight calibration is used in checking these gauges.

At the time of writing, electrodeposits as thin as 0.2 mil have been successfully handled and tested. There seems to be no reason to believe that considerably thinner materials could not be tested. In contrast to the exceedingly difficult operation of mounting very thin materials in the grips of an ordinary tensile testing machine without wrinkling, folding or otherwise distorting the specimen, it is a comparatively simple matter to place the specimen on the boss of the base plate and lower the clamping ring onto it. The central cavity within the boss should be filled with oil before the specimen is put in place. The oil not only supports the specimen, but prevents the inclusion of any appreciable amount of air inside the bulge. Air would not interfere with the test since it transmits pressure as effectively as oil, but any considerable quantity of air in the bulge may lead to an oil-spattering explosion when the specimen fractures. This is not likely to do any harm, but it is a nuisance. When the apparatus is operated as suggested, very little oil is projected onto the surroundings when fracture occurs.

It has been found convenient to use a wide but thin spatula for handling thin specimens. A household utensil designed for turning fried eggs serves the purpose admirably.

The measurement of the height of the bulge at any stage during the blowing of the bulge without any possibility of deforming the thin specimen is accomplished with the aid of the metallurgical-type microscope shown in Fig. 5. It is equipped with an objective whose depth of focus is less than 0.001 inch (0.025 mm). If the operator keeps the top surface of the specimen in focus during the development of the bulge, the microscope tube will move in unison with the top of the specimen to within an accuracy of 0.001 inch (0.025 mm). The movement of the tube is measured by means of the micrometer head, C, which is rigidly attached to the movable tube. A fixed stop, D, on the microscope stand serves as a reference point. The microscope is mounted so that the center of the bulge (the only part of interest) is under observation.

It is desirable to have two operators during the blowing of the bulge—one can keep the microscope in focus and make deflection readings whilst the other makes pressure readings and records both observations.

The deposition of specimens is a matter of prime importance which will be discussed in later papers in connection with the presentation of data obtained in the study of various deposits.

In the next paper of this series, some data obtained from tests on copper deposited from an acid solution will be presented.

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WESLEY F. HALL

A THIRTY-TWO YEAR CAREER of important contributions and service to the electroplating industry has recently been concluded with the retirement of Wesley F. (Wes) Hall from active engineering responsibilities in the Hanson-Van Winkle-Munning Company.

A "Down Mainer" who never lost the accent and mannerisms of the north country, Mr. Hall left Maine and lumbering at age sixteen for Massachusetts to learn tool-making. During that time he practically went through M. I. T. without ever being within those cloistered walls. He took courses through a student, rapidly mastering drafting, machine-designing, and mathematics. Meanwhile, he was developing his penchant toward original engineering thinking. His abilities in that direction brought him, in 1917, to Munning-Loeb Company, Matawan, N. J.

Mr. Hall designed the first practical full-automatic electroplating conveyor to find general commercial favor. This basic design still has wide acceptance and has been much copied. Utilizing the same chain principle, he brought into being another "first" in the heavy-duty semiautomatic conveyor with removable carriers and current collector fingers.

Before that he had brought out a horizontal-type plating barrel, the basic design of which is still the father of all such equipment produced today. Later he improvedup on his semiautomatic conveyor design by successfully engineering a method of oscillation that was probably the first to be marketed.

These achievements made it inevitable for Mr. Hall to become superintendent of the A. P. Munning & Company when it was formed in 1918 from the Munning-Loeb and the George Zucker Companies. During this period he developed the famous Red-E face which is still the mark of quality buffs.

After the consolidation of the A. P. Munning & Company and the Hanson & Van Winkle Company in 1927, Mr. Hall's engineering abilities were allowed full play. Giving all of his time to special equipment for the electroplating industry, he developed the fastest steel-strip cleaning lines then in existence, a straight-line heavy-duty electroplating conveyor incorporating the exclusive feature of rapid return of racks, and a remarkable automatic machine for the continuous plating of zippers.

During World War II he developed and supervised the construction and erection of highly specialized plating equipment for The Manhattan District (atomic-bomb project) and was engaged in the construction of additional types of plating machines for the same project. High-speed strip-cleaning and plating lines were then his chief interests until his retirement.

Mr. Hall has always been civic-minded during this long period of commercial productivity. As a member of the Matawan Civic Club, he furthered many worthy local causes. The high esteem in which he was held is evidenced by the fact that he was Past Master of the Matawan Masonic Lodge.

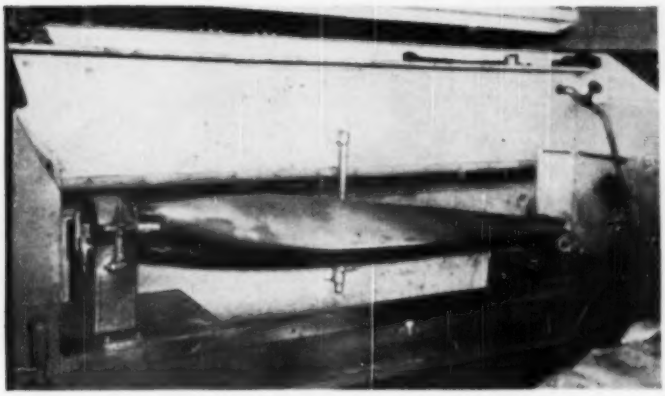
Now that he is retired he is looking forward to pursuing his hobby of traveling the United States and Canada by automobile. Wherever he goes, he will be followed by the good wishes of his many friends.

From the planers the trust member is brought to the grinding room where the inside is hand ground to specification with air-driven grinders. (The grinding-wheel guard was removed for the photograph.) After lead and trailer edges and the center rib of the trust member and the corresponding areas on the camber sheet have been copper sprayed, the two components are welded together at the outboard section, assembled into a fixture, and brazed in a controlled atmosphere. Following X-ray inspection of the brazed areas the assembly is hardened, placed in a heated forming die and filled with nitrogen under pressure to make it hold its shape and prevent any "washboard" effect over the cavities, and subjected to a drawing treatment. It is then pickled in inhibited sulfuric acid and returned to the grinding room.

AIRPLANE PROPELLER PRODUCTION

This description of the manufacturing and finishing of modern airplane propellers has kindly been furnished by the Aeroproducts Division of General Motors Corporation through the cooperation of Mr. B. A. Bowman of its Engineering Process Department. The assistance of Mr. William M. Phillips of General Motors Research Laboratories in procuring this story is gratefully acknowledged.

The outside of the propeller is ground and polished to design specifications. Any indication of thin areas is checked by means of X-ray, by which it is possible to measure the thickness of either side to approximately 0.003 inch.



The finished surface must be smooth to prevent stress risers and air "drag" during use. Blades which have met rigid inspection are grit blasted and washed internally, heated to 200° F, and filled with rust proofing material to coat all areas. The surplus material is removed, and the remaining coating dried with an air stream.

IT WAS some time prior to World War II that Engineering Projects, Inc., a small engineering group headed by the late W. J. Blanchard and C. J. MacNeil, developed an advanced propeller design which featured hollow, rib-reinforced steel blades and new principles of hydraulic pitch control that permitted exceptional simplicity, plus high speed and precision of operation.

At this time General Motors Corporation was looking for an opportunity to devote its talents and production experience to the aircraft field. Negotiations were undertaken between the two organizations, and soon the Aeroproducts Division was formed and a modern plant erected in Dayton, Ohio, the home of the Wright brothers and the site of Wright Field. It was not long before the new propellers were coming off an assembly line where a year before there had been a corn field. They were soon to play an important part in military aviation.

The propeller consists of a hub, enclosing the control mechanism, to which from two to four propeller blades are attached.

The propeller blade is made of two component parts: the reinforced trust member and the camber sheet. The trust member is purchased as a forging of high-strength alloy steel. Its root section, later to be attached to the hub, is turned on lathes, and the outboard section is contoured on large Cleveland planers which do the operation in multiples rather than singly. The camber sheet is surface-ground automatically and formed to airfoil contour in a large press. The operations which follow are described in the pictures and captions.

The hub contains a considerable number of parts. These must meet a variety of service requirements, including close tolerances and resistance to heavy loads, high vibratory stresses, and corrosion by all kinds of atmospheres. All of the parts which control the pitch and speed of the propeller must work perfectly and instantly to assure the safety of flyers and passengers.

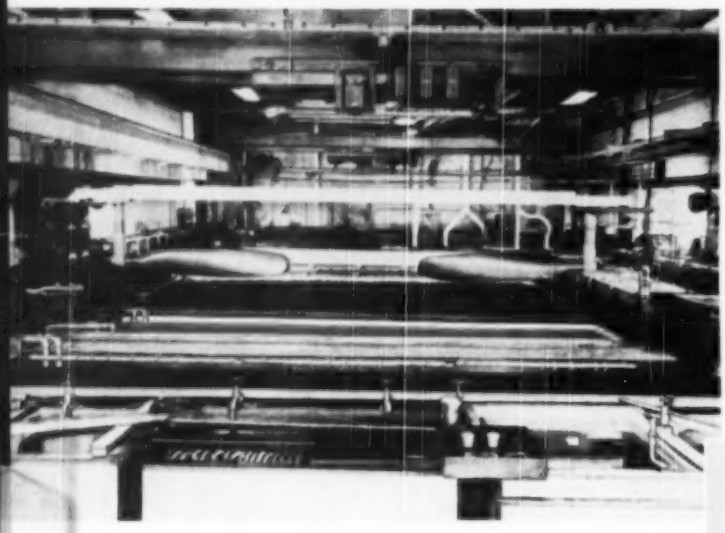
The number of finishes that are used to meet the many requirements is correspondingly large. Most surfaces exposed to the atmosphere are zinc plated in a small line similar to the blade line but containing a tank for application of a yellow electrolytic-conversion chromate treatment rather than a black. A few steel parts require a black-oxide coating for appearance and identification.

Parts making electrical contact are silver plated for positive and instantaneous response as well as for corrosion protection. Many of them are made of a bronze and are copper and nickel flashed to aid the adhesion of the silver plate, all silver coatings being mechanically tested for adhesion before they leave the plating room. Silver plating is done to dimension, in a typical brightener-containing potassium cyanide bath, with a known number of ampere-minutes per unit area.

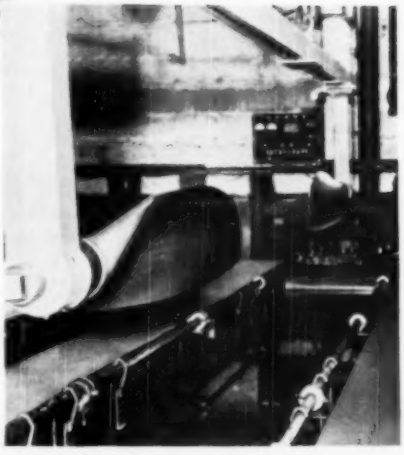
Nickel plating has been employed successfully in several instances for purpose of salvage. An electrolytic sulfuric acid etch is used to clean all steel parts, which are then nickel plated directly in a modified Watts bath which gives a deposit of suitable hardness and finish.

A number of small parts which are to be carburized or nitrided are plated for stop-off.

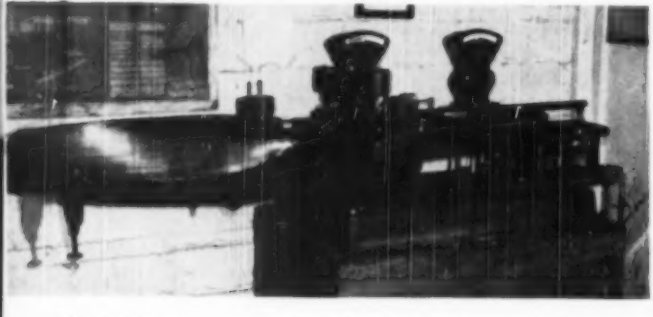
Some parts may even require more than one type of plating.



With their inside cavities sealed off, the blades are mounted in pairs, zinc plated, and given an electrolytic-conversion chromate coating according to the following cycle: (1) Degrease, (2) alkaline clean, (3) cold-water rinse, (4) muriatic acid pickle, (5) cold-water rinse, (6) zinc plate at 80 asf to 0.0008–0.0012 inch thickness, (7) cold-water rinse, (8) neutralizing dip in cream of tartar solution, (9) cold-water rinse, (10) black Anozinc, (11) cold-water rinse, (12) hot-water rinse, (13) blow dry.

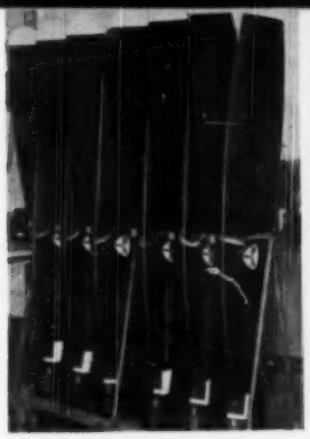


At right a pair of blades are being removed from the passivating electrolytic chromate treatment. Note the seal at the root of the blade.

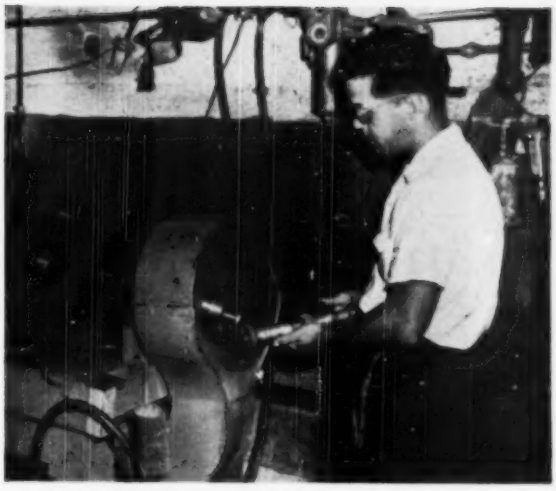


The blade must meet strict balancing requirements both at this point and after subsequent painting. When the blades are assembled in the hub and the assembly is supported by a polished round steel bar resting on knife edges, the balance is such that a dollar bill placed on the tip of any blade in horizontal position will move the assembly.

At right a blade is being spray painted. First the tip is painted yellow, and then the tip and the root section are masked and the remainder of the blade painted black. Statistical data are stenciled and decals applied to the painted blades.



The finished blades are kept on trucks awaiting assembly with the hubs.

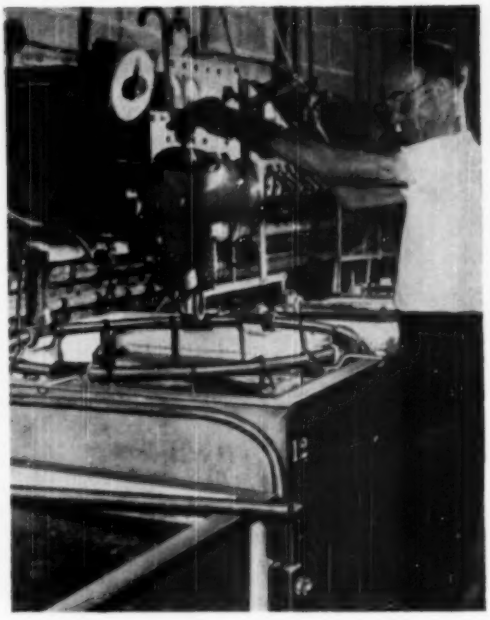


The final operations on the blades consist in finishing the internal surfaces of the root and spraying a zinc chromate primer for protection.

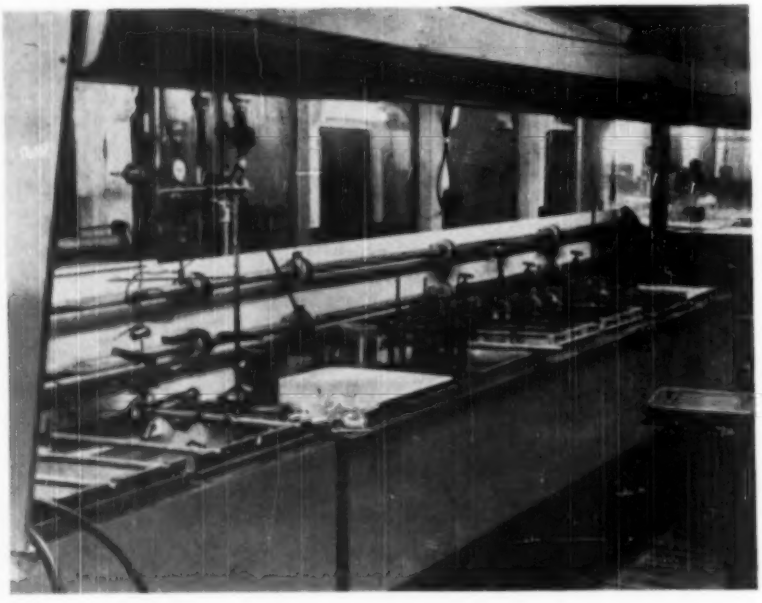
Cover picture: Many gears and splines which go into the hub are honed with a liquid carrying an abrasive powder.

The required close tolerances and the precise plating for stop-off of many small parts make necessary the use of a large variety of meticulously planned and ingeniously designed racks. Some of them are shown on this portion of a racking table. The insert shows one of the many plating fixtures for selective plating.

Some small parts are hard-chromium plated to withstand rough usage.



A two-blade hub is being removed from the zinc plating bath. Although the solution is permitted to enter the hub cavity, the fixture prevents deposition on the inside. This fixture is assembled with the hub in the rinse water which follows the muriatic acid pickle.



A section of the Processing Laboratory where new plating baths and cycles are tried. Some production parts are silver or special-nickel plated in this equipment.

ELECTROLYTIC TINPLATE

its production and benefits

SAMUEL S. JOHNSTON

Weirton Steel Company, Weirton, West Virginia

This "experience paper" was presented at the August 25 session of the United Nations Scientific Conference on Conservation and Utilization of Resources.

In the production of tinplate, as of any manufactured material, the overall cost is usually broken down to include:

1. Cost of raw materials
2. Labor
3. Maintenance
4. Overhead
5. Depreciation and amortization

These costs apply to individual operations within the entire operation, as well as the process as a whole.

Under any economic system, weighted values in terms of the monetary system are assigned to process materials and man-hours, and the amounts of both are computed into cost in terms of money. Cost accounting procedures have been evolved to show the balance between labor and materials costs and to act as guides in keeping them in their proper ratio. Costs in terms of money lose meaning on conversion from one economic system to another, so this discussion will be limited to a comparison of the costs between electrolytic and hot-dip tinplate.

Unit costs are based on the percentage of recovery in saleable form of the total amount of material processed. In production terms, 10–18 tin stacks have the equivalent production capacity of one electrolytic line. If one electrolytic line is producing defective material, 100 per cent of the product is affected. At a higher rate of speed the amount of defective material produced can be great. One tin stack not operating properly affects only 6–10 per cent of the total production and it can be more easily restored to proper operation without a great deal of effect on the total operation. The converse is also true: if 18 stacks are producing off-grade material, they are harder to correct than one electrolytic line. In practice, the recovery of prime plate by the hot-dip method is somewhat higher than by the electrolytic.

Types of Operation

The operations necessary to hot tinning are much the same from mill to mill. Improvements developed in one mill soon find their way into the others.

In contrast, there are two distinct plating systems in use in the production of electrolytic tinplate in the United States. These are:

1. The alkaline system wherein tin is electrodeposited from a solution in which the tin has valence of four
2. The acid system in which the tin is in the stannous form with a valence of two

Each of these systems has at least two variations in the metallic salts used. Plating power costs are, in general, in favor of the acid type electrolyte. This type has, generally, a significantly higher conductivity than the alkaline type which results in the use of less voltage for the amperage required. Higher cathode efficiencies have generally been reported for the acid type bath. Again, the valence difference is in favor of the acid type in that it requires half the amount of current to deposit an equal weight of tin by the alkaline type. This factor supplies leverage so that plating power cost of an alkaline type system can run as high as ten times that of an acid type system. Another characteristic of the acid type system is its ability to produce satisfactory deposits at high current densities (up to 500 asf or 54 amp/dm^2) and over a wide range of current density. This simplifies design and equipment problems in the construction of a high-speed plating unit. Satisfactory commercial operation is reported by each individual user of each system, and the performance of the material produced under the various systems is rated fairly even.

While some plate is used in matte or "as-plated" condition, most of the plate produced is given a heat treatment which fuses the electrodeposited tin and produces a surface very similar to that of the hot-dip product. This heat treatment is carried out in three principal ways:

1. Induction, whereby the coated strip is moved through a high-frequency electrical field and internal molecular friction supplies the heat required to melt the coating
2. Conduction, whereby the strip becomes a resistance element in an electrical circuit.

3. Radiant heating by burning gas

A fourth means which did not gain much usage consisted of moving the coated strip through a hot oil bath. This method, while producing a satisfactory melted finish, did not lend itself well to quick changes of speed and basis weight. Again, the fusion methods in commercial use produce satisfactory finishes and are an accepted integral part of each manufacturer's operation. Cost comparisons are difficult to make because those melting processes with the higher costs have intangible benefits which affect the final yield of prime product.

Production Costs

In comparing production costs of the two processes, the principal differences will be considered according to the cost breakdown category.

(1) *Cost of Raw Materials.*—Steel for tinning, whether by electrolytic or hot-dip means, is processed in the same manner from the open hearth to the temper-rolled coil and hence has the same cost. The tin for both processes has the same price per pound. The first big differential comes in the amount of tin applied. Hot-dip plate in coke grades is supplied in two coating weights: 1.25 and 1.50 lb per base box. The present schedule on electrolytic grades provides three weights: 0.25, 0.50 and 0.75 lb per base box. There is then an important saving in the amount of metal used in the electrolytic process. In addition, sheets produced by hot-dip means carry the so-called "list edge" which results in a waste of many pounds of tin. Edges of electrolytic plate have a tendency to carry a higher coating weight than the rest of the sheet but this does not nearly approximate that of the list edge.

Power might be considered a raw material in the electrolytic process. The power cost, overall, for electrolytic tinplate is of the order of four times that for hot-dip material. If the manufacturer installs generating equipment to produce the power requirements, this will represent a considerable added indirect-capital investment in equipment over and above that actually needed in the plating process.

(2) *Labor.* The electrolytic process is a highly mechanized operation and results in a labor saving in man-hours which amounts to about one-third man-hour of direct coating labor per base box. This labor, however, is more highly skilled, hence higher paid, so the direct labor cost is more of the order of 15 per cent less, rather than 33 per cent.

The development of coating in coils has brought about a change in sorting and reckoning practice. In the shear line for cutting sheets to length, an inspection station is provided ahead of the shear head to permit two girls to inspect for surface defects. One scans the top direct, while the other watches the underside by means of mirrors and proper illumination. Each has a switch to control a gate in the conveyor beyond the shear head and detour off-grade sheets to a reject box.

The reject box gate is also activated by an electronic hole-detector device and an automatic gauge. Consequently, surface defects, holes and light and heavy plate are eliminated, and the plate reaching the end of the shear line is of prime quality. Shipping pallets, or skids, are placed in the piling box at the delivery end to receive the sheets and they are counted as they are piled by a photocell mechanism. When a bundle has received the required number of sheets, a new skid is inserted and a new bundle started. Completed bundles can be removed without stopping the shear and these bundles are covered, wired and shipped without further handling. About 70 per cent of the electrolytic plate produced receives no hand sorting or reckoning. The other 30 per cent consists partly of rejects and partly of prime bundles hand sorted as a check on the efficiency of line sorting. The overall cost of sorting and counting electrolytic tinplate is approximately 65 per cent of that of hot-dip where sorting and reckoning are entirely a hand operation.

(3) *Maintenance.*—Maintenance costs are much higher in the electrolytic process than in hot-dip. Operation of the equipment at speeds up to 1,500 feet per minute, and even higher, demands precision in all parts of all units. Rolls must be accurately ground, which includes rubber-covered rolls as well as steel and other metals. In one production unit there are in excess of 100 rubber-covered rolls which are periodically removed for grinding, and when the original rubber thickness has been ground or worn away, recovered. Life expectancy of rubber-covered rolls is uncertain. Many give long life while others become so badly cut after one hour's service that they must be stripped and re-covered. This work requires a completely equipped machine shop and highly skilled machinists and mechanics for its operation.

Maintenance must be carried out in an orderly manner. Production costs soar when maintenance must be done on operating time.

Maintenance of equipment against corrosion requires labor and material. Tanks, structures and buildings are constantly being checked, washed and painted as a protection against splash and fume of acids and alkalies. The electrolytic process is electrical, as well as mechanical, and requires a great deal of electrical equipment. Motors, generators, fans and wiring all require constant inspection and up-keep. Replacement parts must be ready for instant use in case of breakdown.

(4) *Overhead.*—Overhead is generally associated with fixed charges which are independent of the direct charges of operation. It would be difficult to differentiate this charge for the two types of operation. It is worthy of note that research is regarded as an overhead cost and that the development of the electrolytic process of producing tinplate is largely a result of intensive research. This research is a continuing effort to extend the uses of the electrolytic material, but a great deal of the basic knowledge gained is also applied to producing a better grade of hot-dip product.

(5) *Depreciation and Amortization.*—The capital investment required to install a given production capacity of electrolytic plate is of the order of 2½ times that for the same capacity of hot-dip plate. In addition, while special alloys and rubber coverings are used, corrosive conditions are such that a higher-than-normal depreciation rate is necessary. This charge is much higher for electrolytic plate than for hot-dip.

The important money saving in the use of the electrolytic tinplate is in the difference in the weight of metal applied and the efficiency of its application. The important savings in labor costs are largely nullified by maintenance and depreciation of equipment.

Advantages

There are many advantages of the electrolytic process to the tinplate manufacturer. The steel is handled entirely in the coil form up to and including the coating operation. The required weight of coating is applied in a uniform thickness with a spread which does not vary more than 10 per cent between the high and low values in the sheet. Furthermore, there is great versatility in producing material of different coating weights. There is little more required than readjustment of rheostats to change the coating being applied from 0.25 to 0.75 lb per base box. The uniformity of the coating, absence of the abnormal tin loss on the list edge and the variety of applicable coating weights, make it possible to extend greatly the number of base boxes of tinplate which can be coated with a limited supply of tin.

Applications

The early development work on electrolytic tinplate was aimed to produce a material for the so-called "dry-pack" market which would have adequate protective value, cost less than regular tinplate, and conserve tin. There was already a market for this material in the packaging of coffee, tea, spices, tobacco, baking powder, motor oil, candy, medicinals, etc., for distribution to the consumer. Its use in packers' cans was made necessary by the war with attendant shortages.

For use in packers' cans, electrolytic tinplate had to be evaluated in respect to the following three general properties:

1. Solderability
2. Corrosion resistance to specific packs and processes
3. Susceptibility of the surface to sanitary-enamel systems which enhance the limited corrosion resistance

The problem of solderability was overcome by experimentation with fluxes, solder compositions, and heat variation. There is no problem today, even with the high-speed can lines, in soldering any of the commercial coating weights.

Early work disclosed that adhesion of various lacquers and enamels to any tinplate surface was unpredictable, particularly under process conditions. Close cooperation between the manufacturer, the can companies, and the suppliers of the lacquer systems, plus intensive research on the part of all, has eliminated this problem.

Early work on corrosion resistance of electrolytic tinplate showed that its performance was irregular and hence, unsatisfactory. The use of supplementary organic finishes made the material acceptable for a great many packs. Advances in the technique of steelmaking, composition and treatment, together with improvements in plating technique, have resulted in a marked improvement in resistance of cans to the internal corrosion by materials packed in them. Intensive research has also been applied to canning techniques to reduce the severe corrosion condition of processing. These combined efforts have resulted in a wider application of electrolytic cans, both plain and lined, to process foods.

In applications where limited corrosion resistance is no hindrance, the 0.25-lb grade of electrolytic plate is finding increasingly wider usage. The surface is excellent for lithography and, in some instances, the unmelted coating forms a color base for a multicolor system. This grade of plate is finding wide usage for bottle crowns and closures, beer cans, paints, motor oils, and medicinals. As the supply of tin becomes less critical, this market will expand.

The monetary savings possible in the use of electrolytic tinplate dictate that it be used in place of hot-dip plate wherever possible. This permits more efficient utilization of both iron and tin as natural resources and materially lengthens time that available supplies will last for the benefit of mankind.

Acknowledgment

The author expresses thanks to the Weirton Steel Company for its gracious permission to prepare and present this paper. Acknowledgment is due also to associates in the Weirton Steel Company for their assistance and criticism in the preparation of the paper.

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Determination of Impurities in Electroplating Solutions

XV. TRACES OF SILVER IN COPPER PLATING BATHS

a. e. s. research project no. 2

project director:
EARL J. SERFASS*

associate:
P. BURKHEAD*

location:
LEHIGH UNIVERSITY, BETHLEHEM, PA.

The purpose of this investigation was to develop a simple, rapid and inexpensive colorimetric method for the quantitative estimation of small amounts of silver impurities in copper plating baths, which baths might be further contaminated with Pb, CrO_4, Fe^{+++}, Ca, Al, Ni, Na, SiO_3, and organic material.

A survey of the literature indicated that the reagents most suitable for such a determination are p-diethylaminobenzylidenerhodanine[2,7,11,14] and dithizone[1,11,14].

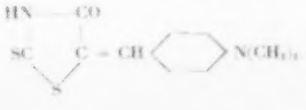
Sheppard and Brigham[14] and others[13] employed 2-thio-5-keto-4 carbethoxy-1,3 dihydropyrimidine with gelatin for the quantitative estimation of small amounts of silver. The method is very similar to the rhodanine procedure and has about the same sensitivity. Yoe and Overholser[14] report that the solutions are more stable than those obtained with rhodanine, particularly for high silver concentrations. This advantage is offset by the fact that from 40 to 50 minutes are required for development of the maximum color intensity. Small amounts of Cu, Co, Fe, and Ni interfere as well as larger amounts of many other ions. In view of these limitations, the method was not investigated. The rhodanine procedure appeared to be the more promising of the two.

A method involving precipitation of the silver with an excess of standard chromate solution and colorimetric determination of the excess chromium with diphenylcarbazide, has been suggested[17].

Sodium dithionate has been used to reduce silver in an ammoniacal solution to form a yellow sol. Many cations interfere, copper in particular; as little as 0.5 mg/l seriously alters the results. For this reason the method was given no further consideration.

Silver may be determined turbidimetrically[12,18]. The method is not very sensitive and is subject to the usual limitations associated with turbidimetric and nephelometric measurements. In such methods the amount of light scattered or absorbed by the variously brought about suspensions is measured. The suspensions are very sensitive to variations in temperature, manner of precipitation, electrolytes present, etc., and are thus reproducible only under very exacting conditions. The method was considered unsuitable as were various nephelometric procedures outlined in the literature[4,5,8,9,10,16].

Feigl[7] reported that p-dimethylaminobenzylidenerhodanine gave a specific re-



Acknowledgment is due the Research Committee, Mr. William Tucker, Eastman Kodak Company, Chairman; the Research Directing Sub-Committee, Mr. B. C. Case, Hanson-Van Winkle-Munning Company, and Dr. R. M. Wick, Bethlehem Steel Company, Chairman and Vice-Chairman, respectively; and the Project Committee, Dr. D. Gardner Foulke, Hanson-Van Winkle-Munning Company, Chairman, Dr. Walter R. Meyer, Enthone, Inc., and Dr. Henry B. Linford, Columbia University, for their contributions to this project.

*AUTHORS

action with silver, sensitive for the detection of one part in about 5,000,000. Kolthoff[7] later reported that Hg and Cu^{+} interfere. Schoonover[13] found the reagent

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suitable for the determination of silver in concentrations ranging from 0.06 to 9 ppm if certain conditions were maintained:

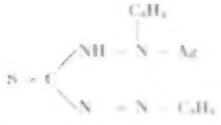
1. The glassware used in handling the solutions must be pyrex or, better, fused silica. Losses of as much as 50 per cent of the silver content occurred when soft glass equipment was employed. The higher the temperature of the solutions, the greater was this loss.

2. The acidity of the solutions must be closely controlled.

3. Salts such as $CaCO_3$, $NaNO_3$, NH_4NO_3, and K_2SO_4, as well as H_2SO_4, interfere seriously as do Cu^{+}, Hg, Pd, and Au. For high precision virtually pure silver solutions would be required.

In spite of these limitations some exploratory experiments with rhodanine were carried out. Gelatin was observed to increase the reproducibility of the suspensions but also to reduce the sensitivity. Carbowax was more effective as a stabilizer. Cooling the solutions to 15° C before the addition of rhodanine solution increased the intensity of the color produced. Even with these modifications good results were not uniformly obtained. Preliminary investigations with dithizone proved more promising and the work with rhodanine was abandoned.

Fischer, Leopoldi, and von Uslar[4] used dithizone in carbon tetrachloride for the colorimetric determination of silver. If the silver is extracted from an acid solution the keto dithizonate is formed.



This compound is soluble in chloroform or carbon tetrachloride giving a yellow solution. When the extraction is from a neutral or basic solution the enol compound is formed.

This compound is nearly insoluble in carbon tetrachloride or chloroform.

Gold, mercury, palladium, and copper react with dithizone in acid solutions, the

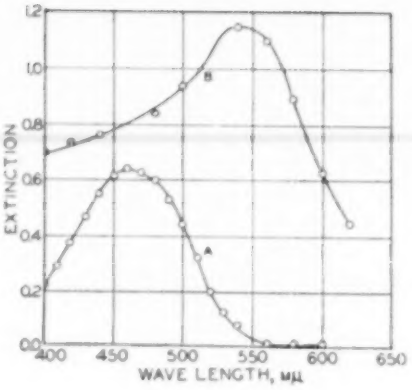


Fig. 1. Extinction versus wave length for (a) silver keto dithizonate and (b) cupric keto dithizonate in carbon tetrachloride

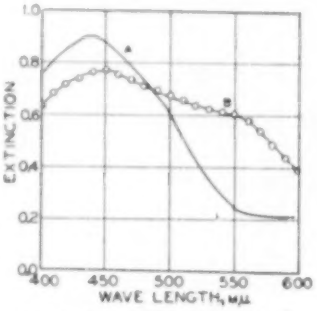


Fig. 2. Extinction versus wave length for (a) enol cupric dithizonate in carbon tetrachloride (after Fischer and Weyl) and (b) a "faded-brown" cupric dithizonate solution. This curve shows peaks for both the keto and enol forms of cupric dithizonate

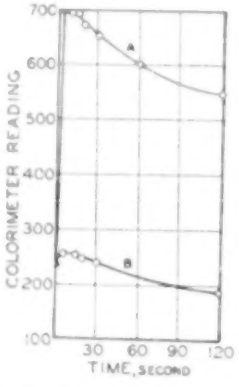


Fig. 3. Colorimeter readings versus time of extraction; (a) one ml $CuSO_4$ plating bath and 20 ml 0.001 per cent dithizone, (b) one ml $CuSO_4$ plating bath plus 100 mcg silver and 20 ml 0.001 per cent dithizone

first three having a greater affinity for dithizone than silver. Silver, however, has a greater affinity for dithizone than copper. Thus, silver in acid solution will replace copper in a carbon tetrachloride solution of cupric dithizonate. Sandell[12] describes a mixed-color method for the determination of silver in the presence of small amounts of copper based on this reaction.

A solution of cupric dithizonate is prepared by shaking a 0.001 per cent dithizone solution (in carbon tetrachloride) with a slight excess of dilute $CuSO_4$ in 0.05-N sulfuric acid for a minute or two followed by washing with 0.01-N sulfuric acid. A constant amount of this solution is used to extract the aqueous silver solutions. The hue of an unknown is compared with the hues of standards prepared in the same fashion. If a colorimeter is used a filter is employed having a maximum absorption at 500 mμ. In this case the transmittancy increases as silver replaces copper in the cupric dithizonate, i.e., it is the reduction in the intensity of the purple color of the dithizonate solution that is proportional to the silver concentration. Sandell[12] found that copper in excess of a Cu/Ag ratio of 250 caused a negative error.

It appeared probable that this method could be adapted to the requirements of this investigation.

Developmental Work

A very simple method would be achieved if conditions could be established such that the cupric dithizonate solution be prepared merely by extracting a normal copper plating bath with a carbon tetrachloride solution of dithizone of known strength. Such an extraction would have to meet the following conditions:

1. The color (and thus the transmittancy) of the cupric dithizonate solution so formed must be reproducible for a given dithizone solution and a given method of extraction (same acidity, time of extraction, washing, etc.).

TABLE I. CALIBRATION CURVE DATA

Silver Added gamma	Colorimeter Readings	Average Reading	Blank Reading	Corrected Average Reading	Mean Average Reading
0	705–698–697	700		702	702
0	705–705–705	705			
0	702–700–705	702			
20	610–598–599	603	702	99	93
20	619–608–618	615	702	87	
40	537–540–533	537	702	165	166
40	540–534–532	535	702	167	
60	448–448–446	447	702	255	253
60	450–449–450	450	702	252	
80	378–376–374	376	702	326	322
80	384–382–384	383	702	319	
100	318–318–318	318	702	384	390
100	311–308–310	310	702	392	
100	310–310–307	309	702	393	

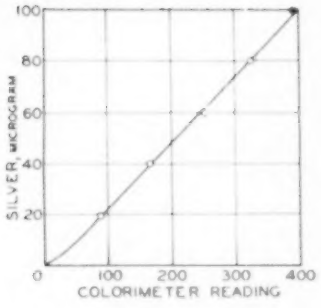


Fig. 4. Calibration curve for silver content versus net colorimeter reading. Klett-Summerson colorimeter with green No. 54 filter

2. The amount of $CuSO_4$ in the portion of the plating solution used must be in excess of that required to convert all of the dithizone to cupric dithizonate. Furthermore, this excess must be sufficient to allow for any reasonable variation in the copper content of a normal plating bath during operation.

3. The amount of copper plating bath used in the preparation of the cupric dithizonate solution must contain concentrations of silver such that complete replacement of copper by silver does not take place.

The maximum amount of silver likely to occur in these plating baths was estimated to be 100 ppm or 0.1 g/l.

The first step in the experimental work consisted of the determination of the transmittancies of silver keto dithizonate and cupric keto dithizonate separately with CCl_4 as the reference liquid. The curves obtained are shown in Fig. 1. A Beckman spectrophotometer was used for this work. It is apparent that the greatest differential absorption takes place in the range 560–580 mμ. If a colorimeter is to be used a green No. 54 filter is adequate.

A 1-ml portion of the pure copper plating bath was used in the preparation of the cupric dithizonate solution, this copper plating bath having been prepared as described in the outline for the recommended routine procedure given later in this paper. Exploratory work showed that an approximately 0.004 per cent solution of dithizone in carbon tetrachloride was of the proper strength for the conditions tentatively adopted.

Sandell recommends an acid concentration of 0.05 *N* for the $CuSO_4$ solution and 0.01 *N* for the washing solution, a minute or two for the time of extraction. Under these conditions and with the quantities of $CuSO_4$ and dithizone used in the tentative procedure, erratic results were obtained and rapid "fading" was apparent. The "faded" solutions acquired a brown coloration. The literature[9] reports that the enol form of cupric dithizonate gives a yellow-brown color in carbon tetrachloride and may be formed not only in basic solution but also in a slightly acid solution when copper is in excess of dithizone. The transmittancy of a brown "faded" solution showed that this transformation was taking place and was undoubtedly the reason for the erratic results. (See Fig. 2.) The effect of acid concentration on the transformation was investigated, as well as the effect of the time of extraction. The latter was found to be the critical variable. The maximum intensity of color is reached in a few seconds, further contact of the dithizone and copper sulfate solutions causing marked reductions in this intensity. (See Fig. 3.) Increasing the acid concentration to 2 *N* for the $CuSO_4$ solution and 1 *N* for the wash solution improved the reproducibility of the color developed. Small variations in these acid concentrations are not important.

Under these conditions, described in detail in the Recommended Routine Procedure, a linear relation between silver content and extinction holds for concentrations of silver between 10 and 100 ppm Ag in the pure copper plating bath. (See Fig. 4 and the calibration curve data in Table I.)

Accuracy and Precision of Method

The conditions for the determination of silver in a pure copper plating bath having been established, the effect of other contaminating substances likely to occur in an operating plating bath was observed. The kind and quantity of these substances is described in Table II. The silica was added in the form of $Na_2SiO_3 \cdot 5H_2O$; the metallic ions as sulfates or nitrates. Chlorides, of course, could not be used and all salts added to the bath must be free of chloride contamination. A slight precipitate is formed when these impurities are added even though the

TABLE II. KIND AND QUANTITY OF IMPURITIES ADDED TO THE BATH

Impurities	Quantity mg/100 ml	Concentration g/l
Aluminum	100	1.0
Calcium	saturated	saturated
Chromic oxide (Cr_2O_3)	20	0.2
Lead	5	0.05
Iron	100	1.0
Nickel	100	1.0
Silica	100	1.0
Sodium	200	2.0
Sugar	1000	10.0

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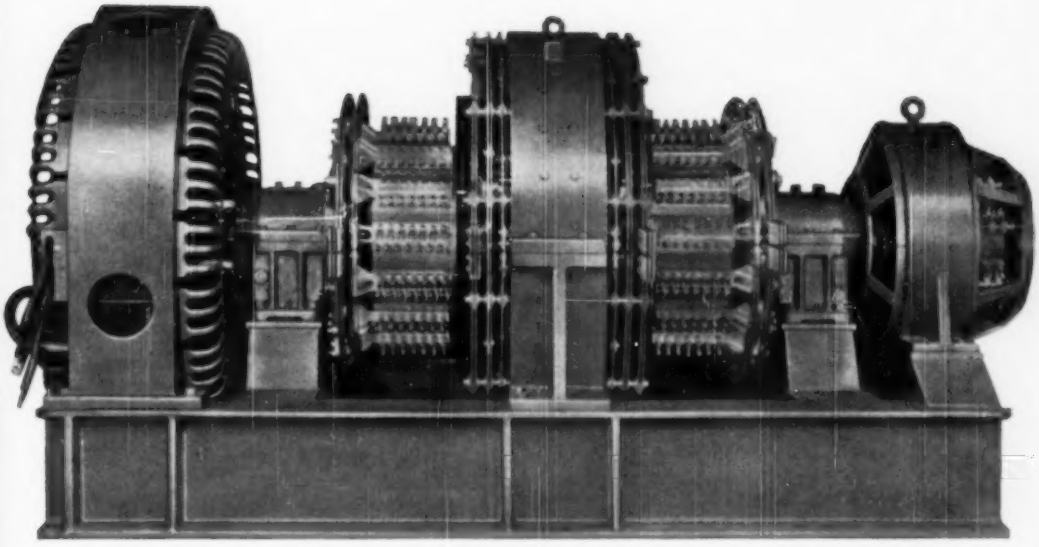

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solution is carried out at room temperature to minimize the hydrolysis of the iron. This insoluble material was filtered out using a No. 40 Whatman filter paper.

The impure bath has a green cast, caused by the iron and chromium present.

The accuracy of the method was reduced by the presence of these impurities. Phosphoric acid was added to the aqueous solution being extracted since iron was thought to be the interfering ion. With this modification, the method gave results having an average accuracy of 5.5 per cent. (See Table III.)

It was observed that the slopes of the calibration curves obtained with different dithizone solutions were not identical. The maximum variation was about 5 per cent. The accuracy of a series of measurements is therefore improved if the calibration curve is obtained with the same freshly prepared dithizone solution.

Samples of a test solution and copies of the recommended routine procedure were sent to several companies for check analyses. The test solution was prepared by adding sufficient standard silver nitrate solution to impart a concentration of about 50 ppm silver to a copper plating bath containing the impurities listed in Table II. The organizations taking part in this work were the Bethlehem Steel Company, Bethlehem, Pa., the E. I. du Pont de Nemours & Company, Wilmington, Del., and the Michigan Bumper Corporation, Grand Rapids, Mich.

The results obtained by these laboratories and the authors of this paper are shown in Table IV.

To test the precision of the method, four samples containing 50 ppm of silver were run. The results are shown in Table V.

These results are considered good checks in view of the fact that the samples had been standing in the various testing companies for several months. Under these conditions the $AgNO_3$ will, to a small extent, become reduced and separate out as metallic Ag thus lowering the analytical value.

Recommended Routine Procedure

Reagents Required

1. Stock dithizone solution—0.01 per cent.
   Weigh out 100 mg dithizone in a 100-ml beaker. Break up all lumps with a glass stirring rod. Add 50 ml carbon tetrachloride and stir the mixture well. When dissolved, filter the solution through a Whatman No. 41 paper to remove any insoluble material. Transfer the filtrate to a 150-ml Squibb-type separatory funnel. Add 50 ml of a 1:100 solution of ammonium hydroxide and shake for about one minute. After the liquids have separated, run the carbon tetrachloride layer into another separatory funnel containing 50 ml of the 1:100 ammonium hydroxide and shake again. Save the orange-colored aqueous layers. The second extraction should remove practically all the dithizone from the tetrachloride, which will be a light green or brown at this point. Discard the carbon tetrachloride and combine the two orange-colored aqueous extracts. Wash the combined aqueous layers four times with 10-ml portions of carbon tetrachloride. This will remove any diphenyl thiocarbodiazone present.
   Precipitate the purified dithizone with 2 ml concentrated HCl and shake for one minute. Finally, extract the precipitated dithizone with 25-ml portions of carbon tetrachloride until the aqueous layer is colorless or a very light green. Run these extracts into a pyrex 1-l volumetric flask and dilute to one liter with carbon tetrachloride.
   To protect the solution against oxidation, overlay it with a 5 per cent solution of pure hydroxylamine hydrochloride, one centimeter thick. Keep the solution in a cool dark place. It is stable for several months if kept in a refrigerator.
2. Dilute dithizone solution—0.004 per cent.
   This more dilute dithizone solution is somewhat less stable than the above and should be freshly prepared for each series of determinations.
   Dilute 200 ml of the stock dithizone solution (0.01 per cent) to 500 ml with carbon tetrachloride in a pyrex 500-ml volumetric flask. This solution will be stable for two or three days if covered with a 5 per cent hydroxylamine hydrochloride solution and kept in a cool, dark place.
3. Phosphoric acid—(cp grade) 85 per cent
4. Sulfuric acid solution—5 *N*
   Add 138.5 ml concentrated cp H_2SO_4 to about 500 ml distilled water in a 1-l volumetric flask and dilute to one liter with distilled water.
5. Sulfuric acid solution—1 *N*
   Dilute 100 ml of the 5-*N* sulfuric acid solution (reagent No. 4) to 500 ml with distilled water.
6. Pure $CuSO_4$ plating bath
   Dissolve 204 grams of pure $CuSO_4 \cdot 5H_2O$ crystals in 500 ml distilled water. Add 49 g cp concentrated H_2SO_4 and dilute the mixture to 1 liter with distilled water.
7. Standard $AgNO_3$ solution—1 g/l Ag.
   Weigh out 1.575 g reagent-quality $AgNO_3$ crystals. Transfer them to a 1-l volumetric pyrex flask and dissolve with distilled water. Add 3.5 ml concentrated cp H_2SO_4 and dilute the mixture to 1 liter with distilled water. This solution should be protected from light and stored in a pyrex flask.
8. Sulfuric acid—concentrated, reagent quality.
9. Carbon tetrachloride—pure grade.

Apparatus Required

1. Volumetric flasks of 1000-ml and 500-ml capacity, preferably of pyrex glass.

TABLE III. ACCURACY TEST

Silver Added gamma	Colorimeter Readings	Average Reading	Blank Reading	Corrected Average Reading	Silver Found gamma
10	606–616–611	611	664	53	9.5
20	570–570–570	570	673	103	22
30	530–532–531	531	673	142	32.5
40	500–495–498	498	673	175	41.0
50	459–465–462	462	673	211	51.0
60	410–413–412	412	673	261	64
70	365–365–365	365	673	308	76
80	358–358–358	358	693	335	83
90	298–300–299	299	673	374	94
100	299–300–297	299	693	394	98

TABLE IV. RESULTS OBTAINED BY COOPERATING LABORATORIES

Laboratory	Silver ppm
A	48
B	52
C	44
D	40

2. Two 150-ml short-stemmed (Squibb-type) separatory funnels.
3. Two 50-ml burettes graduated in tenths.
4. One 1-ml, one 1-ml graduated in tenths, and one 10-ml pipette.
5. One 10-ml and one 100-ml graduate.
6. Test tubes matched for colorimetric use, $\frac{1}{2}$-inch diameter, 15-ml capacity.
7. Klett-Summerson colorimeter with green filter No. 54 (or its equivalent).
8. Watch with second hand.

Procedure

A. Preparation of the Colored Solution

1. Transfer 20 ml of the dilute (0.004 per cent) dithizone solution from a burette to a separatory funnel.
2. Add 8 of the 5-N H_2SO_4 with the 10-ml graduate.
3. Add 0.5 ml H_3PO_4 with the 1-ml pipette graduated in tenths.
4. Add 1 ml of the pure $CuSO_4$ plating bath.
5. Finally add 10 ml of distilled water.
6. Shake the mixture vigorously for exactly 10 seconds (the time *must* be controlled).
7. Quickly transfer the carbon tetrachloride layer to a second separatory funnel containing 20 ml of the 1-N H_2SO_4 and shake vigorously for one minute.
8. Filter the washed CCl_4 layer into a test tube using No. 40 Whatman filter paper. (This will remove any suspended aqueous droplets.)

B. Measurement of Transmittancy

9. Using a clean test-tube cell partially filled with CCl_4 as the reference liquid, adjust the colorimeter so that the galvanometer pointer is at the zero position when the dial reading is zero.
10. Pour out the CCl_4, rinse the test tube a couple of times with small portions of the filtered colored CCl_4 solution from step 8, then partially fill the test tube with this solution. Replace the test tube in the colorimeter and rotate the dial until the galvanometer pointer returns to its original position. Record the scale reading. This scale reading constitutes the blank for the method and an average of three determinations should be used.

Preparation of Calibration Curve

Prepare a dilute $AgNO_3$ solution (0.01 g/l Ag) by diluting 10 ml of the stock $AgNO_3$ solution (1 g/l Ag) to about 500 ml with distilled water in a pyrex 1-l volumetric flask. Add 3.5 ml concentrated cp H_2SO_4 and further dilute to 1 liter with distilled water.

Readings for 20, 40, 60, 80, and 100 mcg (microgram) Ag are obtained in the following manner:

I. Carry out steps (1) to (4) of the Recommended Routine Procedure in five separate funnels.

II. Modify step (5) in the following fashion: Add 2, 4, 6, 8, and 10 ml respectively of the dilute $AgNO_3$ solution (0.01 g/l Ag) and 8, 6, 4, 2 and 0 ml respectively of distilled water to make the total addition to each funnel equal to 10 ml in this step.

III. Continue with step (6) and follow identically the rest of the procedure.

The readings for the solutions containing silver are subtracted from the blank determined as outlined. The corrected readings are plotted against the silver concentrations.

Measurement of Unknown

The transmittancy of an unknown solution is obtained by following the procedure outlined for the determination of the blank, substituting the copper sulfate bath with unknown silver content for the pure copper sulfate bath in step (4). This reading is subtracted from the blank reading, and the resulting net reading is converted to silver concentration with the aid of the calibration curve.

Since these solutions, in the range of concentrations recommended, transmit light in accordance with Bouguer-Beer's Law, it is not actually necessary to prepare a calibration curve (though this is always the safest procedure). If the scale on the colorimeter is logarithmic, the following simplified procedure may be used:

Run a blank and one standard solution containing 50 mcg Ag in accordance with the procedure outlined above. Subtract the reading for the standard solution from the reading for the blank pure $CuSO_4$ extraction. Divide the concentration of the standard solution by the corrected reading for this standard solution. This quotient is the constant "factor" for the method and when multiplied by the corrected reading for an unknown will give directly the concentration of the unknown:

Sample calculation

(a) Blank reading 595
Standard reading, for 50 mcg Ag 395
Corrected reading for standard 200

$$\frac{50 \text{ mcg Ag}}{200} = 0.25 \text{ mcg Ag per scale unit (constant "factor")}$$

(b) Blank reading 595
Unknown reading 495
Corrected reading for unknown 100

0.25 mcg Ag per scale unit x 100 scale units = 25 mcg Ag in unknown

(c) If a 1-ml sample was used, the silver concentration is 25 mcg/ml or 25,000 mcg/l, which is, of course, equivalent to 0.025 g/l or 25 ppm Ag.

Discussion of the Procedure

Silver tends to deposit from dilute silver solutions on soft glass and it is therefore highly advisable to use pyrex glassware in this determination, particularly for storing the standard silver solution.

While some organic matter in reasonable amounts does not interfere with the method (a 1 per cent sugar solution had no significant effect), it is always the safer procedure to destroy organic matter as described in the first article in this series.

The most critical step in the procedure is the time of extraction. Cupric dithizonate, formed in acid solution, is of the keto form and it is this solution which is desired. When, however, the cupric dithizonate is formed in the presence of a large excess of copper, the keto form transforms to the end form which has a very different transmittancy. Such a situation obtains in the outlined procedure, but it was found that if the time of contact during extraction was very limited this effect was negligible. The maximum reading is reached in 5 seconds and falls steadily with increased time of contact. The decrease in reading is tolerable up to 15-second contact and therefore an average contact time of 10 seconds was selected.

The blank reading should be about 600. If it is more than 700, the dilute dithizone solution must be diluted sufficiently to lower it into this range. If the blank reading is below 500, stock concen-

TABLE V. PRECISION DATA

Silver Added gamma	Colorimeter Readings	Average Reading	Blank Reading	Corrected Average Reading	Silver Found gamma
50	476–477–473	475	683	208	50
50	481–478–481	480	683	203	49
50	473–474–476	474	683	209	50.5
50	469–475–472	472	683	211	51

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trated dithizone solution must be added to raise the reading into the proper range.

The best way to assure a proper concentration of the dilute dithizone solution is to measure its transmittancy. With CCl_4 as a reference liquid and a green No. 54 filter a transmittancy of about 230 scale readings will assure a proper dithizone concentration.

"Stop and Go" Method

The color of pure keto cupric dithizonate solution is lavender; the color of pure silver dithizonate solution is yellow. The variation of the hues of the solutions obtained with this outlined routine procedure is sufficiently great so as to permit detection of a difference of 10 ppm Ag visually. The colors may be compared in test tubes.

A series of standards containing 0, 20, 40, 60, 80, and 100 ppm Ag may be prepared in accordance with the outlined procedure. They are stable for a few hours if kept in stoppered tubes. The unknown is compared with these standards.

A very rough estimate of the silver concentration may be made on the basis of the hue of the solution without the preparation of a series of comparison standards. If the routine procedure outlined above is used the following color chart will serve as a rough guide:

Color of Sample	*ppm Ag for 1-ml sample*
lavender	0
	10
	20
	30
rose	40
	50
	60
coral	70
	80
	90
orange-yellow	100
	110
yellow	+

Applicability of the Method

The method may be applied to cyanide baths if the cyanide is destroyed by boiling to copious SO_3 fumes after the addition of an excess of concentrated sulfuric acid.

Summary

Small quantities of silver in copper plating baths may be determined colorimetrically. A carbon tetrachloride solution of dithizone is used to produce the colored solution. The hue or transmittancy of these solutions measured is that of the mixed color of silver keto dithizonate and cupric keto dithizonate. Small amounts of Pb, CrO_3, Fe^{+++}, Ca, Al, Na, Ni, and SiO_2 do not interfere, nor did sugar when present as a one per cent solution. No separation of silver from copper or the listed impurities was required. The method is simple, rapid, and inexpensive and has an average accuracy of 5 per cent, a maximum individual error 10 per cent.

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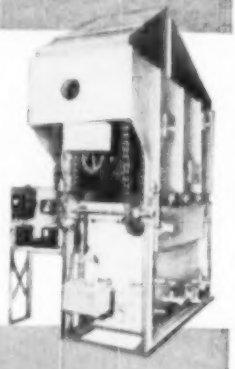

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Book Review

DR. HAROLD J. READ

Associate Professor of Metallurgy, Pennsylvania State College

JOURNAL OF THE ELECTRODEPOSITORS' TECHNICAL SOCIETY, Vol. 23, 1947-1948, 239 pages. Electrodepositors' Technical Society, 27, Islington High Street, London, N. 1, England. Price to non-members, two guineas.

Although there are some papers of interest in this volume, the book as a whole appears to be considerably less valuable than the past several issues. This is not surprising since it would be difficult indeed to maintain the high level of technical excellence which has distinguished the contributions in recent volumes of the Journal.

A rather large portion of the book is devoted to five papers on polishing, none of which is outstanding. American readers will find little information which is likely to be helpful in either improving results or reducing costs.

A long paper on the electroforming of molds might have been interesting if it had been properly written. It is, however, a rambling discussion of experiments and experience which is hard to read and leaves one with no clear idea of what the author considers best practice or what he learned from his experimental work. For example, he says that the insertion of small nickel wires was tried in an attempt to avoid corner weakness, but he fails to state the results of the test.

Several articles deal with methods of testing deposits. Hammond describes a modification of the jet test for lead coatings which suffers from the disadvantage that the reagent must be standardized by titration and is rather unstable. A paper in which methods for measuring the thickness of nickel deposits are compared may be of value, but it would appear that the conclusions were based on too few tests. A shear test for the adhesion of chromium to steel is described in another contribution.

Two papers on speculum plating deal with recent developments and practical uses. A review of bright nickel plating practice in the U. S. A. also covers copper undercoats, but does not present anything which is not readily available in American publications. Miscellaneous articles are to be found on a variety of subjects such as the lead plating of bronze bearing surfaces for fuel pumps, shop layout, masked pores, the motor car *vs.* the weather, bright silver plating, and shop equipment.

A certain amount of interesting discussion is appended to several of the papers, and many electroplaters should find much food for thought in the Presidential Address of Dr. Gardam and the discussion which followed it.

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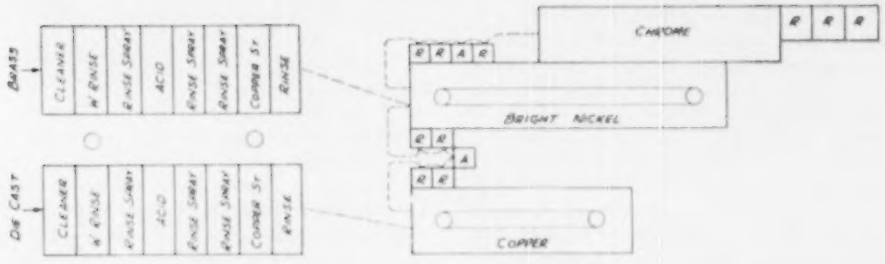

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QUESTION BOX

——————readers' questions of general interest——

Q. 65. Stove cooking tops are normally subject to temperatures up to 725° F in the areas near the burner heads. In plating the tops (made of cold-rolled steel suitable for chromium plating) (1) should we use A.S.T.M.-A.E.S. Designation A166-45T, Type D.S., (2) should we include copper in the deposit, and (3) is spotty discoloration due to a heat reaction of the copper undercoating?

A. The questions are answered by number. (1) To withstand alternate heating and cooling as well as corrosion A.S.T.M. Designation A166-45T, Type D.S. is undoubtedly a much thicker plate than is necessary. The thickness indicated by types F.S., K.S. or an intermediate thickness in the vicinity of 0.001 inch has proved quite satisfactory. However, if abrasion is a problem, then thicker plate will withstand abrasion for a longer time without wearing through.

(2) It has been shown that the thickness of nickel is a far more important factor than the thickness of copper in outdoor exposure and that the copper actually contributes little to the corrosion resistance under such exposure conditions. It seems doubtful that the difference in coefficient of expansion between the base metal and the copper flash is an important factor. Actually both combinations are being used successfully on many steel objects which are heated in use. In my opinion, the principal reason for the use of copper is directly related to the visual appearance of the object. Buffed copper and bright nickel plated to a given thickness will be brighter and smoother than nickel of the same thickness plated directly on polished steel. The matter of finishing economics enters in here but is too involved for this discussion.

(3) It is very unlikely that spotty discoloration of the plate is a result of the heat reaction on the copper undercoating. Nickel which is not covered with a coating of chromium will turn dark when heated in air, and it seems very probable that the removal of the extremely thin chromium coating either by abrasion or chemical attack in spots is the cause of the discoloration.—R. B. Saltonstall.

A. My experience would indicate that a copper undercoat should be omitted. Assuming that you omit the copper underplate, then a preparatory cycle which includes reverse-current etching in sulfuric acid as a step designed to produce maximum adhesion of the nickel plating to the steel should yield nickel plated tops which you could subsequently chromium plate and which should adequately tolerate the temperature of 725° F. The order of thickness would be the same as indicted in A.S.T.M.-A.E.S. Designation A166-45T, Type D.S.

Another approach which, on the basis of personal experience, I am confident would be satisfactory for this service, would be direct chromium plating of the tops with something in the order of 0.0005 to 0.001 inch chromium.—W. M. Tucker.

Additional comments are invited.—Editor.

Q. 66. Which is the better to choose, air-cooled or oil-cooled selenium rectifiers?

A. Four factors are involved. (1) Adequate cooling can be had either by air cooling, as used in the U. S. A., or by oil cooling, as used in England. Natural-convection air cooling is relied upon for smaller units up to 1-kw output, fan cooling for larger units. If local air temperature exceeds 95° F, the fan-cooled rectifier as usually designed should be operated continuously only below its name-plate rating or a stronger-than-normal cooling fan should be used. In oil-cooled units the oil may either be circulated by convection, as in large oil-filled transformers in this country, or with the aid of a pump, as in England.

(2) Provided the oil is completely noncorrosive and the cooling system is not exposed to the atmosphere, oil-cooled rectifiers are completely protected from outside corrosion. Chlorinated oils used in this country for transformer cooling are corrosive and cannot be used with selenium rectifiers. To avoid corrosion, air-cooled rectifiers must either be installed in a reasonably clean atmosphere or be connected by an auxiliary duct to a source of noncorrosive air.

(3) Because there seem to be no noncorrosive oils that are nonflammable there are fire risks with oil-cooled rectifiers. In this country strict regulations require a fire-proof wall around and a dump, or pit, underneath equipment using flammable oil for cooling. This adds to the expense of the original installation and restricts the featured mobility of oil-cooled rectifiers. Such regulations, we are informed, do not apply in England.

(4) Initial cost of air-cooling is obviously higher than of oil-cooling especially if a fire-proof installation is required.—L. W. Reinken.

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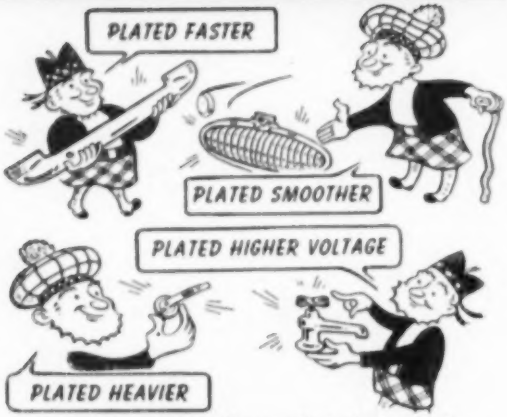

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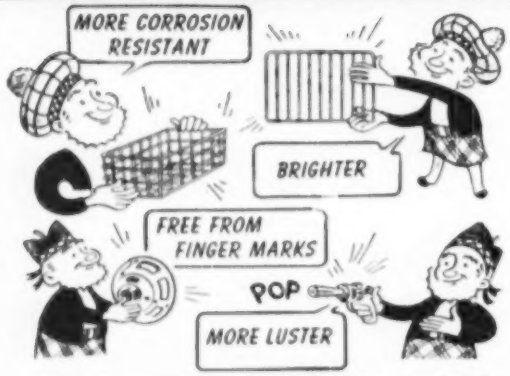

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Article Abstracts

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The Gas Content of Hard Chromium Deposits from Sulfuric Acid Baths. Walter Eilender, Heinrich Arend, and Eugen Schmidtmann. Metalloberflache **2**, 141–143 (July, 1948).
Studies effect of electroplating conditions on the absorption of hydrogen and oxygen by the hard-chromium deposit. Results show that gas absorption increases wih current density and decreases with temperature. Determines conditions for low-gas chromium deposits. Data are graphed.

Plating and Pickling Beryllium-Copper Components. E. E. Halls. Metallurgia **39**, 171–186 (February, 1949).
Oxide films formed during heat-treatment are more difficult to remove by pickling than those on most copper alloys. Gives details of a suitable procedure. Discusses electrodeposition of various metals on beryllyium copper for corrosion protection, soldering assistance, and increased high-frequency conductivity. Data are tabulated.

Formulation of Aluminum Paint Vehicles. Robert I. Wray. American Paint Journal **33**, 46, 49–50, 52, 55, 118, 120 (April 4, 1949).
Discusses general characteristics of suitable varnish vehicles, ester-gum varnishes, coumarone-resin varnishes, pentaerythritol-ester varnishes, terpene-resin vehicles, petroleum resin varnishes, phenolic-resin varnishes, alkyd-resin varnishes, vehicles for interior use, and miscellaneous vehicles.

Cathode Sputtering Grows as Plating Method. Thomas A. Dickinson. Western Metals **7**, 30–31 (March, 1949).
Briefly describes and illustrates this method of applying metallic films to surfaces that are usually nonmetallic, in order to facilitate the manufacture of telescope reflectors, spectrometers, phonograph master records, and many similar products. It is considered superior to electroplating and alloy-spraying processes when the materials are not electrochemically compatible and when extremely thin metal layers must be permanently applied without special binding mediums. It consists of electrically disintegrating a metallic cathode with high-voltage current so that the resultant metal particles will be deposited on an anode-supported surface in a vacuum chamber.

Periodic Phenomena During Electrodeposition of Metals. A. T. Vagramyan. Zhurnal Fizicheskoi Khimii **22**, 1496–1504 (December, 1948).
Applies a new method which permits accurate record-

ing of the periodic fluctuation of potential with time. Such periodic fluctuation for the above indicates four basic steps characterizing the processes occurring during the corresponding time intervals. 15 ref.

The Francis Thickness Tester: Application to the Measurement of Electrolytic and Hot-Dipped Tinplate Coatings. - K. W. Caulfield and W. E. Hoare. Sheet Metal Industries **26**, 753–756, 762 (April, 1949).
Presents results of a study. The instrument was first described by Howard T. Francis in 1948. Slight modifications were incorporated.

The Effect of Heat Treating on the Hardness and Gas Content of Hard Chromium Deposits. Walter Eilender, Heinrich Arend, and Eugen Schmidtmann. Metalloberflache **2**, 143–145 (July, 1948).
Studies show that hardness and hydrogen content decrease with increasing temperature, that no heat-treating operation can alter the oxygen content of the chromium, and that hardness drops with heat-treating time at a decreasing rate. Data are graphed. 12 ref.

Atmospheric Weathering Tests on Anodized Aluminum Reflectors. W. E. Harper, C. A. Morton, and P. Smith. Trans. Illum. Eng. Soc. (London) **11**, 175–201 (1946); Met. Abst. **16**, 712 (July, 1949).
Describes a series of tests of anodized aluminum reflectors exposed for long periods in different locations, both indoor and outdoor, with various degrees and types of atmospheric pollution. The reflection characteristics were determined and the surfaces were examined for pitting. The results show that wetting is a very important factor, the worst conditions being those in a railway-engine shed. Recommendations are made for the best thickness of anodizing, namely 0.0003 inch for a grade-B metal (99.8 per cent) and 0.0005 inch for grade-A (99.99 per cent), to secure the best performance as a lighting reflector.

Surface Treatment and Finishing of Light Metals. III. Mechanical Surface Treatments and Finishes for Aluminum and Its Alloys. S. Wernick and R. Pinner. Sheet Metal Inds. **26**, 1493–1504 (July, 1949).
A lengthy article illustrated with tables and diagrams gives considerable information on each type of treatment and emphasizes the most important points of each.

On the Preparation of Hard Oxide Films with Precisely Controlled Thickness on Evaporated Aluminum Mirrors. George Hass. J. Optical Soc. of America **39**, 532–540 (July 1949).
By increasing the thickness of the natural oxide film on evaporated-aluminum mirrors, a much better surface protection can be achieved. Heat treatment in air is not practical for producing protective coatings on aluminum because the temperature required is more than 400° C (750° F) and oxide films formed at

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this temperature are rough. Oxide films with precisely controlled thickness can be produced on evaporated-aluminum mirrors by anodic oxidation in electrolytes such as ammonium tartrate. The thickness of the oxide layer formed in a given time increases linearly with the applied voltage and is 13.0 A (5.1 x 10⁻⁹ inch) per volt for 2-minute anodizing time. The current efficiency of the anodic process in ammonium tartrate is in the neighborhood of 80 per cent. The thickness of the oxide coatings is 1.38 times that of the aluminum layer replaced. The anodic oxide films formed in ammonium tartrate are amorphous and free of pores. They exhibit no noticeable absorption in the ultra-violet, visible, and infra-red.

Distribution of Metal on the Cathodic Surface in Zincate Electrolytes. N. T. Kudriavtsev and A. A. Nikiforova. J. App. Chem. (Russian) 367–376 (April, 1949).

The authors have made comparative investigation on the distribution of metal on the cathodic surface in zincate electrolytes as affected by the addition of tin, concentration of zinc and caustic alkali, temperature, and current density. The method is based on direct measurement of the thickness of the metal in different sections of an angular cathodic surface. Increase in the concentration of zinc and in temperature decreased the throwing power of the electrolyte, and increase in the concentration of caustic alkali and in the current density increases it. The zincate electrolytes surpass the acid zinc electrolytes and, at low concentration of zinc, are similar to cyanide electrolytes in throwing power. With the recommended potassium or sodium zincate electrolytes zinc of a clear silvery shade is obtained regardless of thickness of the layer.

Joining Coated Metals. E. V. Beatson. Met. Ind. (London) 74, 251–253 (April 1, 1949).

The three standard processes employed for joining coated metals, i. e., soldering, brazing, and welding, are discussed. It is emphasized that the most suitable coating for soldering steel or nonferrous metals is tin. Copper and silver plate are readily soldered with non-corrosive fluxes. Of the protective coatings for steel the relatively new tin-zinc plating appears to be the most readily soldered. Several plated coatings can be satisfactorily brazed. In certain instances, either silver, copper, or zinc plate is used to assist the process or is an integral part of it. For resistance welding, and in particular spot welding, a number of coatings are satisfactory. Probably the most suitable protective coating on steel is electro zinc plate. Whichever process is employed for joining coated metals, it is essential that the plating should be of the highest quality and of consistent specified thickness.

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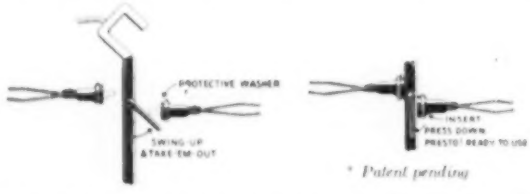

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1— 200 Ampere, 30 V. West.
2— 200 Ampere, 32 V. Gen. Elec.
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Combatting Corrosion with Rubber Lining. R. McFarland. Corrosion 5, 93–99 (March, 1949).

In applying rubber lining for corrosion resistance, the standard commercial practice is to apply a minimum of $\frac{1}{4}$-$\frac{3}{16}$ inch over the metal surface. Where chemical attack is expected, and in the case of soft rubber linings for combined corrosion and abrasion resistance, the thickness is increased to $\frac{1}{4}$ inch minimum. Corrosion-resistant rubber linings are divided into three physical classes: soft linings, semiflexible linings, and hard (Ebonite) linings. The semiflexible lining is composed of a thin, soft layer of tie-gum between the metal surface and the thick layer of specially compounded, semiflexible hard-rubber lining. The Ebonite lining contains the highest ratio of sulfur to rubber hydrocarbons, which when cured forms a highly inert, hard, chemically resistant material. The type of lining for an application depends upon the design of the equipment, type of chemical service, temperature, the required protection against abrasion and corrosion, etc.

The Chemical Coloring of Aluminum. Frank A. Allen. Light Metals 11, 608–609 (1948).

A review is given of the theory, practice, and possibilities of the surface decoration of aluminum alloys. The basic surface finish used was by the M. B. V. treatment, tinted with various inorganic pigments. For outside exposure the coating tends to accelerate bimetallic attack. For interior use these finishes appear to be satisfactory.

The Anodic Oxidation of Aluminum in Oxalic Acid Solutions of Different Composition. W. W. G. Hubner. Dissertation Eidgenossischen Tech. Hochschule (Zurich) 221 pp. (1948). Light Metals Bull. 11, 738 (August 12, 1949).

Following a survey of the development of the process of anodic oxidation an account is presented of the processes in current use with special reference to anodizing in oxalic acid baths and the possibility of producing opaque films by the simultaneous deposition of opacifiers as in the Ematal process. A study was made of the effects of the operating conditions (composition of bath, *p*H, temperature) on the resolution of the film, its formation and its opacity; for example, *p*H values over 2 results in the formation of thin rectifying films with few pores. The opacity depends on the forming voltage and the composition of the electrolyte. Examples of satisfactory operating conditions are given.

Building Organic Protective Coatings to Special Requirements. K. G. Compton. Corrosion 5, 143–150 (May, 1949).

Mass-production manufacturing schedules and special design requirements have created an increased demand for metal paint products based on synthetic resins combined with drying oils. The many ways in which these organic protective coatings can be "tailored" to fit the need of the user are outlined. It is demon-

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strated that organic coatings, in order to provide maximum protection to the metals, must adhere well, be hard and tough enough to withstand impact and scraping, have flexibility, and withstand such environmental factors as moisture or chemical fumes. The compromises that must be made among the physical properties to obtain the proper balance are discussed. Examples are given of organic finishes which have been specially devised.

Cylinder Chrome Plating Lengthens Engine Life. Anon. Aviation Operations **2**, 19–22, 46 (May, 1949). The porous-chromium plating practice at Kelly Air Force Base is described. An aircraft cylinder so plated will outwear a standard steel cylinder several times and will not rust or otherwise corrode. The chromium surface is almost diamond hard, yet has a special oil-retaining surface effect, which allows perfect engine operation at an extremely low rate of oil consumption. "Channel-type porosity" produced by chemical means has been adopted by both the U. S. Air Force and the Navy and is described in detail. Over 3,000 R-2000 engine cylinders for C-54's flying the Berlin airlift were plated monthly at Kelly Air Force Base to support the Vittles engine program.

Defects in Anodic Oxidation Due to the Presence of Chlorides. J. Herenguel and R. Segond. Rev. Aluminum **26**, 52–54 (1949).
The formation of a dense oxide film in anodic oxidation is sometimes impeded by too much chloride. The chloride ion content should be less than 0.4 per cent.

Microchemical Control of Chromium Plating Baths. F. K. Gerke and others. Zavodskaya Laboratoriya **12**, No. 11–12 (1946); Henry Brutcher, Altadena, Calif., Tech. Transl. No. 2049.
Describes methods of chemical analysis for hexavalent chromium, trivalent chromium, iron, sulfate, and copper in baths for the electrodeposition of chromium.

Electrolytic Pickling of Wire. K. I. Tulenkov. Stal **7**, No. 8 (1947); Henry Brutcher, Altadena, Calif., Tech. Transl. No. 2272.
Experimental study of best conditions for the electrolytic pickling of steel wire subsequent to continuous patenting. Wires studied were stranding wire with 0.3 and 0.45 per cent carbon and spring wire with 0.9 per cent carbon. Data are given on experimental installation devised by author and on procedure, and comparative evaluation is made of an electrolytic pickling process and conventional chemical pickling.

Anodizing of Aluminum Wire and Strip. N. D. Pullen. Electroplating **3**, 3–8 (September, 1949).
Problems involved in the anodic treatment of continuous lengths of wire, foil, and strip and the principles underlying the design of a commercial plant are discussed with particular reference to domestic as well as electrical applications.

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Patent Abstracts

By GEORGE B. HOGABOOM

Consultant, New Britain, Conn.

Copies of patents may be obtained by writing to Commissioner of Patents, Washington 25, D.C. Price 25 cents each.

No. 2,479,670, August 23, 1949—Electroplating Baths and Method for the Electrodeposition of Zinc—Allan E. Chester and F. F. Reisinger, assignors to Poor & Company, Chicago, Ill.

In the electrodeposition of zinc from alkaline cyanide electrolytes in accordance with the invention, it has now been found that the incorporation of a chromic aldonate into a cyanide zinc plating bath makes it possible to electrodeposit zinc over a wide range of current densities without burning the plated material. Furthermore, by employing cyanide-zinc plating baths of the type herein described, semibright, very smooth zinc plated finishes having a pleasing uniform color are obtained with lower M ratios (ratio of total sodium cyanide to zinc metal) than heretofore used in obtaining brightening effects. Additionally, cyanide-zinc plating baths containing chromic aldonate have enhanced throwing and covering power.

The term "chromic aldonate" is used herein to describe compounds of trivalent chromium with aldonic acids which may also contain alkali metals, or the like, in their molecules . . . In our copending application, which has matured into United States Patent No. 2,428,356, we describe the chromic aldonates.

CLAIM 5. A method of electrodepositing zinc from an alkaline aqueous cyanide-zinc plating bath having a M ratio within the range of 1.75 to 2.2 to which has been added 30 to 60 cc per gallon of a bath product of the reaction of an approximately 50 per cent aqueous solution of gluconic acid containing less than 1 per cent of reducing sugars, and an aqueous alkaline solution of a chromium compound selected from the group con-

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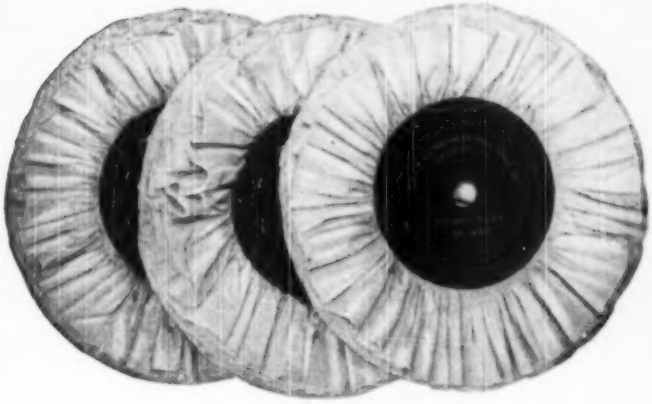

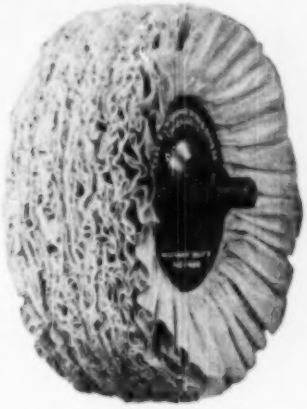

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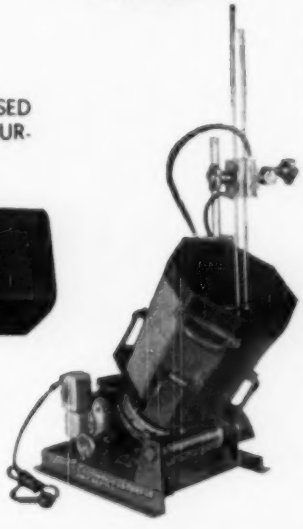

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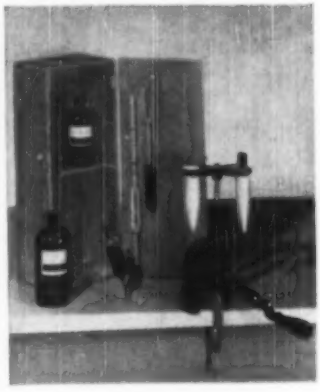

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sisting of trivalent and hexavalent chromium compounds, the ratio of the gluconic acid molecule to the chromium atoms being at least 1:1, said product existing in the form of a clear green stable solution in water, and effecting said electrodeposition at current densities within the range of 25 to 250 amperes per square foot.

6 claims.

References cited: U. S. Patents 694,658; 2,080,520; 2,218,734; 2,233,500; 2,406,072; 2,428,356; 2,443,600.

No. 2,473,918, June 21, 1949—Control System for Electrolytic Processes—G. E. Stoltz and J. E. Erbe, assignors to Westinghouse Electric Corporation.

The present invention relates, generally, to control systems and, more particularly, to the control of the electrolytic treatment of continuously moving lengths of material (e. g., electro tin plating of strip steel).

CLAIM 1. In a control system for an electrolytic process employing a plurality of electrolytic baths, variable-speed means for causing a length of material which is to be electrolytically treated to move through the baths, means for supplying current to the electrolytic baths, separate means for varying the current supplied to the separate baths, regulator means jointly responsive to the current flow in the separate baths, means for selectively connecting said regulator means in controlling relation with one of said current-varying means to maintain a predetermined ratio between the currents supplied to the separate baths, and means responsive to the speed of travel of the strip and the current supplied to at least one of the baths for so controlling said variable-speed means as to maintain a predetermined relation between the speed of travel of the length of material through the baths and the current flow in the baths.

13 claims, 2 figures.

Literature cited: U. S. Patents 1,917,657; 1,965,399; 2,125,037; 2,325,401. German Patent 427,436.

No. 2,475,974, July 12, 1949—Electrodeposition of Copper—Abraham M. Max, assignor to Radio Corporation of America.

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It is apparent that a desirable structure for electroformed copper deposits is one in which the columnar growth is retarded completely. I have found that if triethanolamine is added to a standard acid-copper plating solution, the resulting solution will produce fine-grain deposits both laterally and perpendicularly to the surface which is plated, the columnar crystal growth being retarded. Tensile tests made with specimens of such copper deposits show a tensile strength equal to that of a strong copper alloy . . . from 60,000 to 75,000 psi.

CLAIM 2. The method of producing on an article a fine-grain deposit of copper comprising immersing said article in a solution consisting essentially of approximately 25 to 32 ounces of copper sulfate, approximately 3 to 10 ounces of sulfuric acid and approximately 0.7 to 1.0 ounce of triethanolamine per gallon of plating solution and then electrodepositing copper from said solution onto the surface of said article.

2 claims.

References cited: U. S. Patents 694,658; 1,642,238; 1,805,920; 2,391,289. British Patent 503,095. Trans. Electrochem. Soc. *21*, 261 (1912).

No. 2,475,586, July 12, 1949—Method of Electropolishing the Internal Surface of Hollow Valves—K. M. Bartlett, assignor to Thompson Products, Inc., Cleveland, Ohio.

CLAIM. The method of electropolishing the inner surface of the stem of a hollow valve which comprises positioning a hollow electrode in said stem, flowing an electropolishing electrolyte through said hollow electrode into said valve while permitting the excess of said electrolyte to overflow from said valve, making said inner stem surface the anode and said electrode the cathode, and while continuing said electrolyte flow passing an electric current from said anode through said electrolyte to said electrode of sufficient current density and for a sufficient period of time to effect a polishing of said inner stem surface and to render said inner stem surface free from any amorphous layer.

NOTES FROM LEGEND. Suitable metals and their alloys for forming the type of valve here under con-

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sideration are the following: nickel-chromium-iron alloys such as Nichrome steel; nickel-molybdenum-iron alloys such as Hastelloy steel; nonferrous nickel-chromium alloys such as Brightray; and cobalt-chromium-tungsten alloys such as Stellite.

As a result of considerable research, concentrated orthophosphoric acid at a temperature between 50 and 150° F has been found to give the most satisfactory results . . . The ratio of anode to cathode area for best results should not vary very greatly from the ratio of 3.5 to 1.0 . . . The entire electropolishing operation requires in the neighborhood of forty minutes . . . at about 0.5 ampere per square inch . . . When about 0.17 gram of chromium is present for each 10 ml of electrolyte, the electrolyte may be regenerated or a new electrolyte used.

1 claim, 2 figures.

References cited: U. S. Patents 883,756; 1,501,862; 1,850,426; 2,070,102; 2,332,569, 2,347,040; 2,373,459. British Patent 335,003. French Patent 577,030. Proc. Am. Electroplaters' Soc. 20–27, 104–112 (1941). Metal Industry 69, 70 (January 29, 1943).

No. 2,480,156, August 30, 1949—Electrodeposition of Iron—A. E. Matson and H. V. Trask, assignors to Buel Metals Company, St. Paul, Minn.

CLAIM 1. The method of making electrodeposited iron of pure brittle character by two stages of electrodeposition which comprises subjecting an electrolyte consisting essentially of ferrous chloride and containing from 150 to 250 grams of iron per liter of solution to electrolysis in a cell having cathodes and insoluble anodes and wherein from 2 to 10 per cent of the iron is oxidized to ferric iron, withdrawing the electrolyte from said cell, cooling at least a portion of it, adding free acid thereto and introducing the electrolyte so conditioned into a second cell containing cathodes and insoluble anodes produced by electrolysis in the first mentioned cell, subjecting said solution to electrolysis in the second cell to produce a brittle deposit on the cathodes therein, maintaining in the second cell an aqueous solution consisting essentially of ferric and ferrous chloride at a total concentration of from 150 to 250 grams of iron per liter of solution of which from 1 to 5 grams is ferric iron, maintaining the temperature of the solution below 50° C (122° F), the *p*H from 1 to 1.2, and the current density not less than 25 amperes per square foot, withdrawing the electrolyte from the second cell and reintroducing it into the first mentioned cell for further electrolysis therein.

CLAIM 2. . . . continuously withdrawing another portion of the electrolyte from the first mentioned cell and enriching its iron content and returning the enriched electrolyte to the first mentioned cell.

CLAIM 4. . . . thereby produce a brittle, coherent iron deposit containing hardening oxygen and hydrogen compounds removable by annealing and less than 0.5 per cent of other impurities, then pulverizing the brittle deposit to particles of shapes and sizes suita-

ble for compaction in forming dies, and annealing the resulting powder in a reducing atmosphere.

6 claims, 2 figures.

References cited: U. S. Patents 1,980,381; 2,157,699; 2,223,926; 2,287,082; 2,385,269. British patents 10,655; 543,137; 549,954. French Patent 813,426. Trans. Electrochem. Soc. *80*, 503–504 (1941); *84*, 305, 306, 308, 309 (1943).

No. 2,484,540, October 11, 1949—Lead Coating Process —I. P. Whitehouse, assignor to Republic Steel Corporation.

CLAIM 1. The process of lead coating a metal article which comprises the steps of electrodepositing a coating of lead on such an article and closing pin holes in the coating and increasing the resistance of the article to corrosion by frictionally wiping said coating with soft, fibrous material while the coating is in a mineral oil.

CLAIM 2. ... while the coating is in vegetable oil.

CLAIM 3. ... while the coating is in a liquid lubricant.

CLAIM 4. ... frictionally wiping the surface of the coating with a cloth while the coating is in a liquid lubricant.

4 claims.

References cited: U. S. Patents 685,211; 1,580,198; 1,869,041; 2,125,578; 2,141,382; 2,177,316; 2,318,592. British Patents 2,460; 130,302; 484,103; 639,701. "Protective Coatings for Metals", R. M. Burns and A. E. Schuh (1939), pp. 34, 207, 208. Iron Age 29-41 (April 30, 1942).

No. 2,485,149, October 18, 1949—Bright Nickel Plating Composition and Process—M. L. Freed and O. A. Slocker, assignors to The Seymour Manufacturing Company.

These results and the invention may be illustrated by, but not restricted to, the following examples which include the sodium salt of the product of the reaction of sulfuric acid with 2-mercapto-6-methyl-4-6-diethyl-dihydropyrimidine, hereafter for brevity referred to as "agent A", as a particularly effective specific example of a sulfuric acid reaction product of an alkyl-substituted 2-mercapto-dihydropyrimidine and ortho-sulfobenzaldehyde sodium salt, hereinafter sometimes for brevity referred to as "agent C", as a specific example of the sulfonated aryl aldehyde. Thus good bright nickel electrodeposits can be obtained directly by employing the indicated conditions in the following baths, and which deposits possess good ductility.

	Range	*Optimum*
Nickel sulfate ($7H_2O$), oz/gal	27–45	37
Nickel chloride ($6H_2O$), oz/gal	6–9	8
Boric acid, oz/gal	4.5–8	5
Agent "C", g/l	3–8	5
*p*H electrometric	3.5–5.5	5.0
Temperature, ° F	110–130	120
Average current density, asf	1.5–100	25

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CLAIM 1. A nickel electroplating bath addition-agent composition comprising a nickel electrodeposit-brightening agent consisting essentially of (I) a sulfonated aryl aldehyde and (II) a sulfonic acid reaction product of an alkyl-substituted mercapto-dihydropyrimidine, said reaction product resulting from reacting an alkyl-substituted 2-mercapto dihydropyrimidine with concentrated sulfuric acid with accompanying evolution of sulfur dioxide from the reaction mixture which is heated until such evolution has substantially ceased, and having the aldehyde (I) and the reaction product (II) in the ratio of from about 0.5 to 3 parts of the aldehyde (I) to from about 0.005 to 0.02 part of product (II), said addition agent composition being capable, upon addition to an aqueous acid nickel plating bath comprising in solution in its aqueous medium a nickel-ion-yielding material consisting essentially of a mixture of nickel sulfate and nickel chloride, of causing a bright, ductile cathode deposit of nickel to be obtained upon passing an electric current from the anode through said bath to the cathode when the sulfonated aldehyde and the sulfuric acid reaction product of the substituted mercapto-pyrimidine are present in the bath respectively in combined, cooperative quantities sufficient to permit the bright, ductile deposit of nickel to be obtained under the operating conditions.

25 claims.

References cited: U. S. Patents 2,294,311; 2,361,720; 2,409,119. Trans. Electrochem. Soc. *80*, 547 (1941).

No. 2,483,996, October 4, 1949—Method of Reconditioning Backing Members Having Powdered Material Facings—Frank De Marinis, assignor to S. K. Wellman Company, Cleveland, Ohio.

CLAIM 1. A method of reconditioning backing members of ferrous material which are copper plated and have bonded thereto layers of defective sintered metal mixtures having copper as their major constituent and comprising also essentially tin, lead, iron, carbon and silica, which comprises chemically treating said member in a 10 to 20 per cent solution of sodium cyanide without the use of electric current, thereby dissolving the copper only and reducing the layers to a residue of loosely attached material, then mechanically removing said residue, and electroplating with copper the members in the solution thus obtained.

2 claims.

References cited: U. S. Patents Re. 22,283; 699,108; 925,321; 1,050,678; 1,774,901; 1,787,139; 1,798,607; 1,818,379; 2,241,585; 2,284,743; 2,287,654; 2,316,579. Metal Cleaning and Finishing 464, 465, 466, 475 (Nov., 1933). "Principles of Electroplating and Electroforming", Blum and Hogaboom, 2nd ed. (1930), p. 360.

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E—373. Adhesive—H-511 Unibond, a synthetic-rubber cement developed by the Union Bay State Chemical Company of Cambridge, Mass., now makes possible the precementing of many metals, rubbers, plastics, wood, etc. The precemented surfaces can be joined together at a later time, on an assembly line or even after shipping to point of use, without loss of adhesion, it is claimed, by heating the "dead" surfaces under infrared, steam or dry heat, or by brushing or spraying it with a solvent.

Upon application, the adhesive dries to a non-tacky condition after a period of from 15 to 30 minutes at room temperature. For samples for testing, use Reader Service Card.

E—374. Automatic Concentration Control—Milton Roy Company, 1300 E. Mermaid Lane, Philadelphia 18, Pa., manufacturer of controlled-volume chemical pumps and chemical feed systems, offers the "Titronic" Pump and Automatic Concentration Control System which affords precise, continuous concentration control in caustic or acid baths, even where it is impossible to measure changes in value by direct methods. The system utilizes one side of a Duplex Controlled Volume Pump to titrate automatically and continuously a sample from the liquid bath. The other side of the pump meters to the sample, in direct ratio and exact proportion, a fixed quantity of the titrating medium. For further information, use Reader Service Card.

E—375. Gold Rolling Process—Karat gold can now be rolled to a mirror finish and as thin as electroplate on any nonferrous metal base through the development of the Inter-Weld Process by the Gold Filled Division of the American Silver Company, Inc., 36-07 Prince Street, Flushing, N. Y. It is claimed that manufacturers of fountain pens, compacts, costume jewelry, novelties, cosmetic items, buckles, buttons, etc., will find this new method a tremendous time saver over the conventional method of manufacturing from brass, polishing and electroplating. The filled gold layer is said to be tougher and longer wearing than gold electroplate of comparable thickness.

Improving on the so-called "Old Sheffield Process" wherein a layer of karat gold is silver soldered to a base metal, the ASC Inter-Weld Process welds the gold layer to a barrier layer of pure nickel after which this dual thickness is soldered to the base metal in the conventional manner.

ASC Inter-Welded rolled gold plate is furnished in rolls, the coils interleaved with tissue or if preferred protected by a plastic strip coating which may be left on during the stamping and drawing operations. For further information, use Reader Service Card.

E—376. Safety Spectacles—New safety spectacles have been developed by the United States Safety Service Company, Kansas City 6, Mo., under the trade name "Saf-I-Spec". Among features are the one-piece plastic lens which can be replaced or adjusted instantly. Patented,

quickly detachable temples may be instantly attached to the outside edge of the lens, making it possible for the wearer to adjust the temples to make them fit correctly and to be comfortable. The lens has an integral molded sweat-bar and a patented design which gives unusual rigidity and still prevents it from getting out of alignment, is optically correct, and is available in crystal clear or anti-glare green. The spectacles can be adjusted to wear over personal glasses. For further information, see Reader Service Card.

E—377. Glass-Pipe Coupling—The Fischer & Porter Company, Hatboro, Pa., announces a new threaded metal coupling for use with Pyrex-glass pipe lines. The new coupling is said greatly to simplify the installation of glass piping by replacing three-bolt triangular-metal flanges. The use of wrenches is no longer necessary and perfect alignment is assured. The danger of breakage due to uneven take-up is eliminated. Installation time is reduced up to 60 per cent in comparison with alternate methods. Metal couplings are available from stock in sizes $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$ and 1-inch for making glass-to-glass or glass-to-metal connections. For further information, use Reader Service Card.

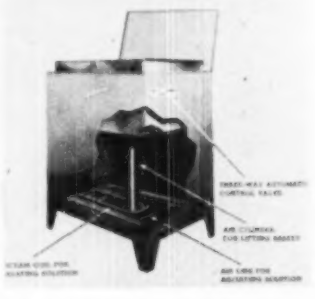
E—378. Electric Immersion Heaters for Strongly Acid Solutions—Sheathed in Carpenter Stainless Steel No. 20, the new line of "Electro-Therm" electric immersion heating units, manufactured by Electro-Therm, Inc., 8024 Georgia Avenue, Silver Spring, Md., can be used in boiling sulfuric acid up to 25 per cent solution, and in all concentrations up to 176° F. These units can be supplied in straight lengths up to 176 inches and can be bent with a minimum radius of $1\frac{1}{2}$ inch thus permitting them to be shaped to specifications. Rated at from 200 to 5000 watts and from 115 to 550 volts, they are regularly supplied with lug terminals, although other fastenings can be supplied to order. For further information, use Reader Service Card.

E—379. Cold Pipe Insulation.—A new lightweight pipe and vessel insulation has been developed by Robinson Industries, Coleman, Mich. Known as K-Shield, the material is made of Styrofoam, an expanded plastic containing thousands of minute closed-wall cells. It is said to be a highly workable, rigid material which has high moisture-vapor resistance and an uncanny resistance to mold growth, rot and decay.

It is manufactured for all standard pipes and fittings and custom fabricated to specifications for process equipment such as tanks and pumps. For further information, use Reader Service Card.

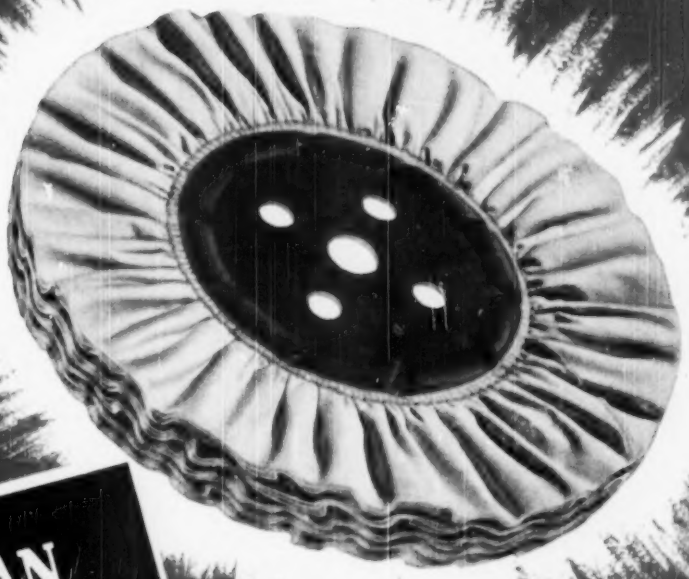
E—380. Plated Round-Edge Flat Wire—American Nickeloid Company, Peru, Ill., has recently announced the availability of round-edge flat wire. Furnished in nickel or chromium finish on one or two sides of a steel base, this material is said to find wide usage among manufacturers in such decorative and functional uses as trim, furniture parts, toys, trunk hardware, displays, and in pin ball machines. A variety of sizes are furnished. For further information, use Reader Service Card.

E—381. Dip Tank for Cleaning Metal Parts—A completely automatic dip tank for cleaning of metal parts is announced by the Hopkins Equipment Company, 36 Maple Avenue, Hatfield, Pa. The "Dip-O'Matic" eliminates all manual labor in its operation. A three-way finger-tip con-



trol air valve automatically lowers and raises the specially designed basket in solution. There are no motors—fire hazards are eliminated. There are no pumps or gears to wear out. Steam heat maintains cleaning solvent at proper temperature, or cold solutions may also be used.

Holiday Greetings



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CODMAN
COMPANY
ROCKLAND · MASSACHUSETTS

FOR OVER FIFTY YEARS THE GREATEST NAME IN BUFFS

THE MARK OF QUALITY

Equipment and Supplies

Automatic temperature controls are optional equipment. Floor space is 2 x 3 feet. For further information, use Reader Service Card.

E—382. Detergent—Five new anionic foaming detergents, known as the Antarons, have been added to the list of Antara Products, General Aniline and Film Corporation, 444 Madison Avenue, New York, N. Y., manufacturers of all types of detergents, wetting and dispersing agents. The new anionics are alkyl amide sulfonates and are companion products to Antara's non-ionic Antarox series—aromatic and aliphatic polyglycol esters and ethers.

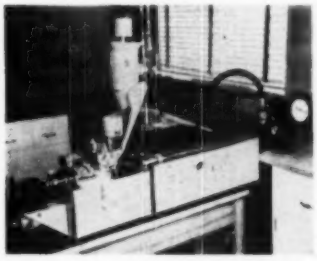
Antaron N-185 is soluble in water, including hard water, and moderately soluble in electrolyte solutions. It is stable in acid and alkaline solutions, boiling water and in the presence of metal ions. It may be used in metal cleaning as a steel pickling-bath assistant and in neutral or alkaline metal degreasing. Antaron L-114 may be used in most of the places that Antaron N-185 is used. Antaron R-275 may be used in metal cleaning with Antarox A-130 for non-alkaline metal degreasing, and as a wetting agent where acid or alkali stability are required. For further information, use Reader Service Card.

E—383. Long-Scale Electric Panel Instruments—A complete new line of 3½-inch, long-scale panel instruments of internal pivot-type construction has been announced by General Electric's Meter and Instrument Divisions. Designated as Types DO-81 (direct current), DO-82 (thermo-couple), and DO-83 (rectifier), the new instruments employ standard 3½-inch round and square cases with 250-degree scales, 4.92 inches long for good readability. The complete line, which falls into the 2-per cent basic accuracy class, is mechanically interchangeable with the 3½-inch round, wide-flange, and rectangular designs now listed.

Housed in molded Textolite cases which are dustproof and moisture resisting, the instruments are made for flush mounting on non-magnetic or steel panels. Because of the self-shielding characteristics of the concentric magnet, no special calibration is required for mounting on steel panels. For further information, use Reader Service Card.

E—384. Self-Cleaning Filter—High operating efficiency with a minimum of maintenance attention is the principal feature claimed for a new filtering-system designed by Commonwealth Engineering Company, Dayton, Ohio. The completely automatic system is said to work efficiently with all types of solutions; even difficult slimes such as those from cyanide plating tanks or composed of iron and aluminum hydroxides have been successfully filtered.

As developed in the laboratory apparatus, a revolving drum with perforated cylindrical surface is coated with a filter



aid. The drum is submerged in the filter tank which is directly connected by piping to the plating tank. The solution passes through to the interior of the drum under the influence of suction supplied by a pump, impurities are trapped in the filter cake and clear filtrate returns to the plating tank. To accomplish the self-cleaning function, the drum revolves against a blade set at the top to remove the spent filter layer, which is transported up a ramp and dropped to a disposal container. Immediately back of the blade is the slurry chamber in which filter aid is received from a hopper above and diluted with fresh solution from the plating tank. The aid deposits itself on the drum to replace the spent layer. An electrical control system regulates the intermittent rotation of the drum and the supply of slurry mixture.

When it comes to specifying a rust-resisting or friction-reducing chemical finish for a production run of steel parts, whatever they may be, there are many advantages to selecting Du-Lite, particularly if you want to avoid trouble and keep production up to schedule.

Du-Lite produces on all steel and steel alloy parts except stainless a handsome, uniform jet black finish. Not a coating, Du-Lite becomes an integral part of the steel surface itself and will not chip, peel, crack or blister.

Imposed at non-critical temperature, Du-Lite causes no dimensional change in the parts treated. The process is simple to operate and inexpensive to install.

To guarantee the success of every Du-Lite installation there is available a trained, technical representative in your area who will get you started and find the "workable" answers to every problem that arises.

While matching or excelling in every respect any other process for the chemical blacking of steel, Du-Lite remains less costly to operate than most. Do it right with Du-Lite. . . . . write or phone today.

DO IT RIGHT WITH DU-LITE

The DU-LITE CHEMICAL CORP.

140 RIVER ROAD **MIDDLETOWN, CONN.**

WRITE or PHONE TODAY to

Teamwork THAT PAYS OFF

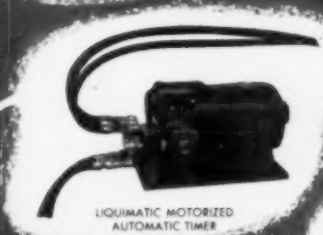
LIQUIMATIC PUMP

Here's a team to avoid!

Liquimatic and the Liquimatizer — the right combination for trouble free, high production finishing.

Proper application of compound is an important factor in the complete finishing cycle. The Liquimatizer offers complete automatic application and incorporates these important features: "On" and "Off" time controlled positively by a unique motorized automatic timer interchangeable cams set "On" and "Off" valves for individual treatment on any buffing head; fluid regulating valves to control individual gun or head pressure; total elimination of line loss air piston pumps for using Liquimatic direct from shipping container and high quality spray guns, featuring optimum apertures.

Liquimatic and the Liquimatizer are engineered to work together as a perfect team to bring you perfect buffing results.



LIQUIMATIC MOTORIZED AUTOMATIC TIMER

PORTABLE EQUIPMENT

Portable equipment for demonstration, can be quickly set up parallel to existing equipment thereby eliminating the slow operation of line down time. A demonstration on your plant, using your process will tell the story. Write us, or your nearest Liquimatic representative for production

LIQUIMATIC EXTRACTOR E-75

LIQUIMATIC EXTRACTOR 544-A

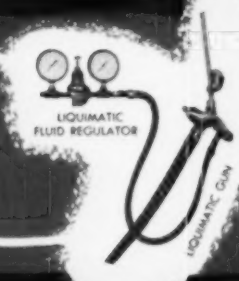
Liquimatic

LIQUID BUFFING COMPOUND

Liquimatic, the modern liquid buffing compound, incorporates these unique features:

1. [illegible]
2. [illegible]
3. ASSURES DEVELOP APPROVAL BUFF [illegible]
4. [illegible]
5. NON-[illegible]
6. HIGH FLASH [illegible]
7. LONG STORAGE [illegible]
8. SPRAYABLE VISCOSITY

Investigate Miller Liquimatic for [illegible]



LIQUIMATIC FLUID REGULATOR

LIQUIMATIC GUN

MILLER BUFF

J. C. MILLER COMPANY

GRAND RAPIDS 4, MICHIGAN

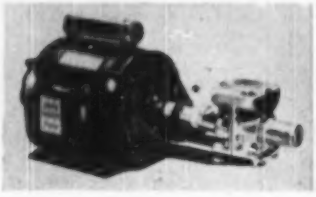
WRITE FOR ILLUSTRATED CATALOG

A request on your company letterhead will bring complete Liquimatic information.

Equipment and Supplies

Unusually high flow rates have been achieved in the new design. The pilot apparatus in sustained operation has reached a flow of five gallons per minute per square foot of filter. For further information, use Reader Service Card.

E—385. Motor-Driven Pump Units—A line of close-coupled electric-motor-driven gearless pump units has been developed by Eco Engineering Company, 12 New York Avenue, Newark 1, N. J.



This compact assembly is made by means of a pump supporting bracket attached to the shaft and bell housing of the motor. The motor and pump shafts are connected by a heavy-duty flexible coupling.

The pumps are available in stainless steel and naval bronze with 1/4-, 3/8-, 1/2- and 3/4-inch ports. They are said to serve for both simple circulation work and heavy-duty against 150 psi. The motors are capacitor-start, induction-run single-phase models and are supplied in 1/4, 1/3 and 1/2 hp. Three-phase motors are also available. For further information, use Reader Service Card.

E—386. Electric Immersion Heater—A new series of all-stainless or all-Inconel Chromalox electric immersion heaters is available from Edwin L. Wiegand Company, 7578 Thomas Boulevard, Pittsburg 8, Pa. It is used for heating a wide range of industrial chemicals, strong alkaline cleaners, extra-heavy degreasing solutions, and other corrosive liquids which do not attack stainless steel or Inconel.

The heaters are constructed of hair-pin shaped heavy-duty Chromalox tubular elements welded into a solid screw-plug with 2-inch standard pipe thread and a heavy 3-inch hex section. The heating elements are die-pressed to a triangular cross-section for high mechanical strength and a more dense refractory. This affords a better electrical insulation between the sheath and the resistor wire, and results in a maximum degree of heat transfer.

Heating elements, screw-plug, and welded joints are all made of the same alloy-Type 347 18-8 Cb-stabilized stainless steel, or nickel-chrome Inconel.

The heated length of the element ranges from 12 to 50 inches. For further information, use Reader Service Card.

E—387. Portable Hoist—The "Lug-All" Portable Hoist made by Lincoln Precision Machining Company, North Grafton, Mass., weighs only 8½ pounds, is capable of lifting 1½ tons, and may be used by a single worker. Designed with a minimum of parts, it can be repaired right on the job with just a wrench and a screw-driver.

The handle may be reversed so that the user can take advantage of easier operating conditions in tight places. Instead of a chain, it employs a 133-strand aircraft cable which reels out easily without snagging. Limit for the cable is 15 feet, at which length the hoist capacity is 1500 pounds. Doubled (length 7½ feet) the hoist's capacity increases to 1½ tons. For further information, use Reader Service Card.

E—388 Treatment for Leaky Faucets—Leaky faucets are said to be quickly and permanently repaired with O'Malley "Nu-Seater" tools together with new brass seats designed for easy screw-driver insertion into faucet, manufactured by Edward O'Malley Valve Company, 7602 Greenwood Avenue, Chicago 19, Ill. The low-cost set, in a metal box, contains everything needed for removing cuts from faucet seats, tapping thread, and installing new seats on up to ¾-inch faucets as well as globe and angle valves. Chart on inside of door of set shows step-by-step procedure in the 7 phases of faucet repair. For further information, use Reader Service Card.

E—389. Spray Nozzle—A new spray nozzle has just been announced by the Bete Fog Nozzle Company, Greenfield, Mass. The new line has a unique spiral design that produces a finer atomization yet is practically non-clogging, according to the manufacturer. The nozzles shear from a single high-velocity jet a

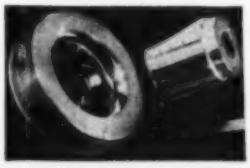
continuous film which readily breaks up into uniformly fine particles at relatively low pressures. There are no vanes or whirl discs.

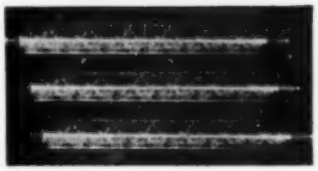
Nozzles are available in various spray patterns and with flow rates from ¼ to 100 gpm. For further information, use Reader Service Card.

E—390. Aluminum Cleaner—A cleaning bath that is claimed effective on aluminum work pieces which are heavily coated with polishing composition, especially in recessed areas, is composed of a mixture of from 2 to 4 oz/gal of Northwest "Alkalume No. 1" plus 2 per cent by volume of Northwest "Liquid Stripper No. 2". Parts are processed through this bath for a period of from 2 to 5 minutes at from 160° to 190° F depending on the transfer time and are then thoroughly rinsed.

According to the manufacturer, Northwest Chemical Company, 9310 Roselawn Avenue, Detroit 4, Mich., complete removal of the soil is accomplished without scrubbing preliminary to the usual painting, anodizing, or plating cycle. For further information, use Reader Service Card.

E—391. Self-Regulating High Speed Chromium Bath—United Chromium, Inc., has announced a new chromium plating bath which is said to differ from the conventional solution in several respects. It is self regulating, only the specific gravity being maintained by addition of Compound Cr-100. At usual current densities cathode efficiencies are 50 per cent higher, permitting one-third reduction in plating time and power cost. As





illustrated, the current-density range for bright plate is about twice as wide, allowing higher current densities without burning and because of the higher covering power eliminating part of the need for expensive auxiliary anodes. The bath activates bright nickel better, hence rainbow effects or gray nickel seldom appears.

The properties of the chromium are the same as usual, and standard chromium-plating equipment is used. Numerous commercial installations are already in operation. No license agreement need be signed. The bath will shortly be sold also in Canada through United Chromium, Ltd. For further information, use Reader Service Card.

E—392. Illuminator for Pocket Microscope—Buhl Optical Company, Desk T-131, 1009 Beech Avenue, Pittsburgh 12, Pa., has announced a special illuminator for use with its S-129 Pocket Microscope.

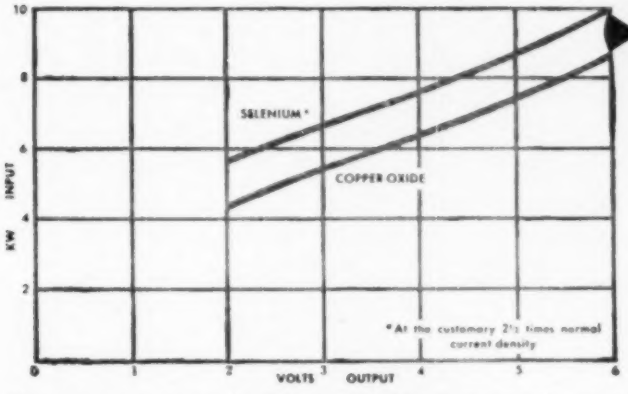
Using a standard-size flashlight battery and bulb, the illuminator furnishes illumination of uniform intensity throughout the field. It is attached to the microscope tube by means of a heavy spring clip and can be removed instantly when not required. For further information, use Reader Service Card.

Here's how

COPPER-OXIDE RECTIFIERS

cut your power costs

15% less power for typical plating job



This curve shows power consumption for 1000-ampere electroplating operations at varying voltages. All data is based on what we consider the most efficient circuit for complete plating rectifier and regulator equipment. The copper-oxide curve is based on G-E fan-cooled rectifier stacks. The selenium curve is based on G-E fan-cooled stacks operating at the usual 2½-times-normal current density.

Greater Efficiency — At six volts d-c output, copper-oxide rectifiers show a 15% decrease in your power costs. With 3 volts d-c output, the difference is even greater — 18 per cent in favor of copper oxide.

Long Life—Copper-oxide rectifier cells age only slightly during the first year and then are stable. Their life is practically unlimited. As proof, the majority of all rectifiers in service over five years have copper-oxide stacks. Some stacks have been in service for over 20 years.

Proved in Service — Installed capacity of G-E copper-oxide rectifiers, in the plating industry alone, is over 5,000,000 amps.

General Electric makes all types of rectifiers. We could choose either copper-oxide or selenium stacks for electroplating equipment. However, considering the greater efficiency and more stable aging of copper-oxide stacks as compared with selenium, we use only copper-oxide rectifiers for our plating equipment.

Your plating equipment represents a major investment. Get all the facts before you choose. Your local G-E representative, who handles both copper-oxide and selenium rectifiers, is in a position to give you impartial facts on plating rectifiers. Ask him to give you Bulletin GEA-5247. Or write *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

456-301

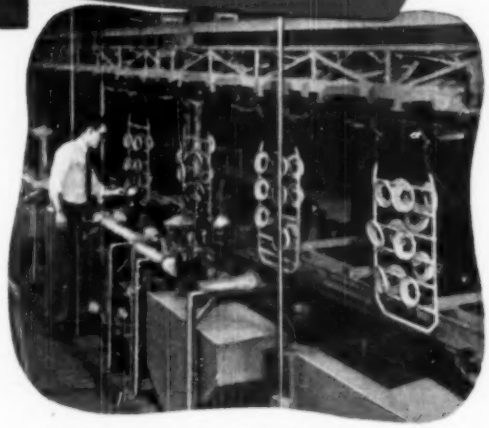
A CHECKERBOARD OF PRODUCTS PROTECTED BY *Udylite Automatic Plating*

PRODUCTION IMPROVED — — REJECTS CUT IN HALF!

In the development of the famous U. S. Rubber "Brass-O-Matic" process for a permanent bond between rubber and metal, high quality plating was of primary importance. U. S. Rubber engineers turned to Udylite with their problem, with results that have paid off handsomely. Their Ft. Wayne plant has a top notch performance record to report. They say:

1. **"Cost of materials per-unit-plated is about the same, BUT — —**
2. **"The percentage of plated parts requiring re-processing has been cut in half!**
3. **"The new layout using Udylite equipment has reduced direct labor by 27%;**
4. **"Overall floor space requirements in the Plating Department have been greatly reduced, providing necessary space for storage of plating chemicals and supplies; and . . .**
5. **"Maintenance time required to keep units in good operating condition has been reduced substantially."**

Every day, more and more shrewd production men are turning to Fully Automatic Plating Equipment—designed, installed and applied by The Udylite Corporation. Perhaps you have a plating problem in your plant! If you have, we will be glad to make recommendations entirely without cost or obligation. See your local Udylite representative or write today.



UDYLITE EQUIPMENT IN THE
U. S. RUBBER CO.,
FORT WAYNE PLANT

THE *Udylite* CORPORATION
DETROIT 11, MICHIGAN

Trade Literature

L—296. Water Conditioning—A 16-page revised edition of Bulletin 4021 describes Cochrane Carbonaceous Zeolite Water Conditioning equipment for softening industrial process waters, manufactured by Cochrane Corporation, 17th Street and Allegheny Avenue, Philadelphia 32, Pa. Seven typical installations are illustrated and a number of application flow diagrams is included, with curves, tables and the chemical reactions involved. For your copy, use Reader Service Card.

L—297. Centerless Polishing Machine—Production Machine Company, Greenfield, Mass., offers a 4-page illustrated Bulletin Type A" Polishing Machine" which describes and gives specifications for a duplex-belt machine for polishing

round parts of $\frac{1}{8}$-6-inch diameter. Tapered parts can be handled by a separate attachment. This 25-year old machine has recently been redesigned for quick change of feed belts, better adjustment to the parts being polished, improved safety and dust control. It was shown for the first time at the recent Cleveland Metal show. For your copy, use Reader Service Card.

L—298. Protective Coatings—Latest 4-page bulletin on Ucilon Protective Coatings issued by United Chromium, Incorporated, 51 E. 42nd Street, New York 17, N. Y., gives information on four groups of coatings expressly developed for corrosion control, chemical resistance, and "heavy duty" industrial painting. Essential facts on various formulations are briefly outlined, and as evidence of their unusual chemical resisting qualities, cases are cited where systems of Ucilon coatings ended tough maintenance problems. The coatings are applicable both to structural surfaces and to equipment in interior locations. For your copy, use Reader Service Card.

L—299. Selenium Electroplating Rectifier—A 2-page illustrated Bulletin 248 issued by The Electric Products Company, 1725 Clarkstone Road, Cleveland 12, Ohio describes its 2000/1000 ampere, 6/12 volt selenium rectifier, including component parts, controls, and electrical and mechanical characteristics. For your copy, use Reader Service Card.

L—300. Temperature Controls, Relays, Thermometers—H-B Instrument Company, 2633 Trenton Avenue, Philadelphia, Pa., offers a 16-page guide for selection of H-B Double-Diamond equipment used in signaling and controlling temperature in both laboratory and plant installations. Equipment illustrated and described includes panel-mounted or enclosed normally-open and normally-closed mercury relays, having hermetically sealed contacts that accommodate 30 amperes at 115 volts A.C., single and multi-contact, thermo-regulators, automatic over-temperature cutouts, complimentary relays and selector switches, mercury thermostats and temperature controls. For your copy, use Reader Service Card.

L—301. Burnishing Balls—A 2-page Products Data Sheet issued by Pioneer Steel Ball Incorporated, 37 Mill Street, Unionville, Conn., contains technical data and statistical tables which provide answers to the questions most frequently asked about steel balls for bearings, stainless steel balls, bronze balls, and burnishing balls and other shapes for tumbling-barrel applications. For your copy, use Reader Service Card.

L—302. Fume Duct Lining—An illustrated 2-page literature piece issued by The Ceilcote Company, Rockefeller Building, Cleveland 13, Ohio describes the application of Ceilcote materials to fume ducts carrying acid, alkaline or other chemical fumes. For your copy, use Reader Service Card.

L—303. Air-Operated Controllers—A 32-page illustrated Bulletin No. A120 describing the new line of Series 500 air-operated controllers has just been published by The Bristol Company, Waterbury, Conn. The bulletin gives information about the new instruments for automatically controlling temperature, pressure, flow, liquid level, humidity, and *p*H value. Complete data with pictures is given on on-off, proportional, reset derivative, and reset plus derivative models. For your copy, use Reader Service Card.

L—304. Metal Industry Handbook—The 36th edition of this English reference work is now available to subscribers to Metal Industry, the journal published by The Louis Cassier Company, Ltd., Dorset House, Stamford Street, London, S. E. 1, England. This edition differs from the 35th, which was reviewed in the February, 1949 issue of PLATING, in that new data has been added to the sections on Metal Statistics, Expansion of Alloys, and Proprietary Alloys. The official British specifications for alloys has been brought up to date, and a number of U. S. alloys have been removed from the section on Proprietary Alloys.

L—305. Blast Cleaning—"How Wheelabrating Has Replaced Acid Pickling" is a new bulletin 584 issued by American Wheelabrator & Equipment Corporation, 555 S. Byrkit Street, Mishawaka, Ind. It describes how this method of airless blast-cleaning offers economical, fast, efficient metal cleaning. Numerous case histories are related, and safety hazards and other features of this method are discussed. For your copy, use Reader Service Card.

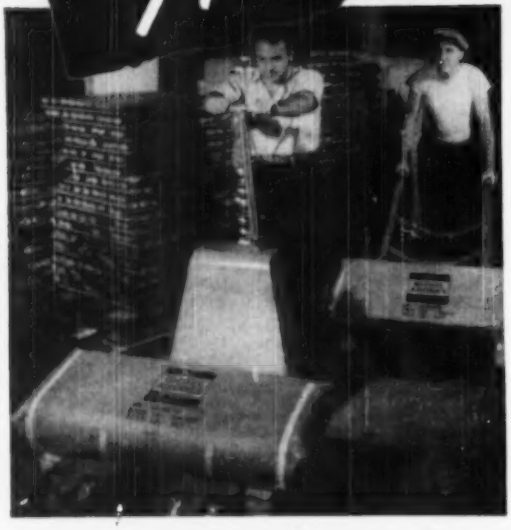
L—306. Corrosive-Handling Process Equipment—A new 12-page Catalog M issued by The Duriron Company, Dayton 1, Ohio condenses the data, published in 54 separate bulletins on corrosive resisting equipment and alloys, for handy yet complete reference. Arranged alphabetically for easy reference, with complete production range indicated, the reader can tell at a glance what is available and for what corrosive service it is suitable. For your copy, use Reader Service Card.

L—307. Quickly Reversible Control Valve—In a few minutes' time and without the use of special tools the new Foxboro Stabilflo Valve can be changed from "air to open" to "air to close", or vice versa; and it is not necessary to remove the valve from its installation or to shut

down the controlled flow. The new valve is described and the simple reversing operation explained in an illustrated Bulletin 2268 published by The Foxboro Company, Foxboro, Mass. The new design is now standard for Foxboro Stabilflo Valves in the most common sizes. For your copy, use Reader Service Card.

L—308. Low-Pressure Oil Burners—An 8-page Catalog No. 409, just released by Hauck Manufacturing Company, 124 Tenth Street, Brooklyn 15, N. Y., covers fully its series "B" low-pressure air-atomizing oil burners for manual operation and individual oil and air control. For your copy, use Reader Service Card.

HARSHAW *Packaged Anodes**



easy to handle
easy to open
no deposit
no return
no extra cost
keeps anodes clean

Harshaw now fills your orders with a compact package of anodes with skids attached. Easy to stack or move by hand or with mechanical truck. When you are ready to use the anodes unwrap the package and throw the wrapping away. No deposits—no containers to return. Order Harshaw PACKAGED Anodes.

*Patent applied for.

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A. S. T. M.-A. E. S. SPECIFICATIONS FOR PLATED COATINGS

All numerical requirements refer to minima on significant surfaces.

Zinc on Steel: A164

Coating	Type G.S.	Type L.S.	Type H.S.
Zinc, inch	0.001	0.0005	0.00015

Cadmium on Steel: A165

Coating	Type N.S.	Type O.S.	Type T.S.
Cadmium, inch	0.0005	0.0003	0.00015

Nickel-Chromium on Steels: A166

Coating	Type D.S.	Type F.S.	Type K.S.	Type Q.S.
Copper plus nickel, inch	0.0030*	0.00125	0.00075	0.0004
Final nickel, inch	0.0010	0.0006	0.0004	0.0002
Chromium (if required), inch	0.00001	0.00001	0.00001	0.00001
Resistance to standard salt spray, hours without appreciable corrosion	96	72	48	16

*When copper is used in excess of a thickness of 0.0001 inch, its minimum thickness shall be 0.00075 inch.

Nickel-Chromium on Copper and Copper-Base Alloys: B141

Coating	Type F.C.	Type K.C.	Type Q.C.
Nickel, inch	0.0005	0.0003	0.0001
Chromium (if required), inch	0.00001*	0.00001	0.00001

*Maximum thickness should be kept below 0.00005 inch to prevent cracking.

1273

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Nickel-Chromium on Zinc and Zinc-Base Alloys: B142

Coating	Type F.Z.	Type K.Z.	Type Q.Z.
Copper plus nickel, inch	0.00125	0.00075	0.0005[a]
Copper, inch	0.0004	0.0003	0.0002
Final nickel, inch	0.0007	0.0003	0.0003
Chromium (if required), inch	0.00001	0.00001	0.00001
Resistance to standard salt spray, hours without appreciable corrosion	48	32	16

[a]Total of 0.0003 inch if alternative of nickel only is used.

Lead Coatings on Steel: B200

Type	Copper inch	Lead inch	Salt spray Resistance[a] hours
E.S.	.....	0.0010	96
EE.S.	0.000015	0.0010	96
M.S.	.....	0.0005	48
MM.S.	0.000015	0.0005	48
P.S.	.....	0.00025	24
PP.S.	0.000015	0.00025	24

[a]To standard salt spray test in hours without appreciable corrosion.

Chromate Finishes on Zinc: B201

With two crossing, 1-inch long scratches through the chromate coating only, the part shall show no white corrosion visible to the unaided eye at normal reading distance after 24 hours in a standard salt spray test.

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A. E. S. News

United Nations Scientific Conference on Conservation and Utilization of Resources

Two of the members of the Society's Executive Board attended this conference, Past President S. S. Johnston who on August 25 presented an experience paper on "Electrolytic Tin Plate—Its Production and Benefits" published in this issue, and Third Vice-President F. J. MacStocker who served as official observer.

Some of the comments in their reports to the Executive Board are of interest. Not less than about 600 papers were presented, among them one or two each from Yugoslavia and from Poland. Some 49 nations had sent representatives, but none seemed to be present from the countries under the domination of the U. S. S. R. Most were from government agencies.

Two papers beside the one by Mr. Johnston were of interest to electroplaters. One by U. R. Evans of University of Cambridge, England, dealt with the "Role of Protective Coatings in Conservation of Metals"; the other by F. L. LaQue of The International Nickel Company with "Prevention of Corrosion by Means Other than Protective Coatings".

Western Ontario Branch Receives Permanent Charter

October 21 was the date and William Pitt Hotel, Chatham, Ontario, the place where Second Vice-President C. F. Nixon presented the permanent charter to the Society's forty-third full-fledged branch.

A representative group from the mother branch in Detroit was present to offer congratulations. Besides Mr. Nixon, who is also Detroit Branch President, they were Messrs. Frank L. Clifton, Secretary-Treasurer; Herberth Head, Chairman of the Board of Managers; and Robert Redman, Second Vice-President.

The charter was received by Western Ontario's President, Mr. Harvey Curry, who in his acceptance speech expresed the Branch's appreciation and its determination to develop in the right direction. These sentiments were echoed by the Secretary-Treasurer, Mr. Douglas E. Paton, and many other members.

The Society's best wishes go to the new Branch.

A Letter to the Ladies Who Attended the Aunt Ella Luncheon at the Milwaukee A. E. S. Convention

I regret to inform you that the tickets which you filled out with your names and home addresses have been lost. For the past four months we have tried desperately to locate them—without success.

Therefore, if you were one of the ladies who attended the above luncheon and

(Continued on page 1284)

A. E. S. 37th ANNUAL CONVENTION BOSTON, JUNE 12-15

The Educational Sessions

A substantial part of the meeting of the A. E. S. Editorial Board held in Chicago on October 14 was devoted to the educational program at the Boston Convention.

Mr. Myron B. Diggin reported offers of four papers for the session dealing with chemical and electrochemical smoothing and levelling. Such processes are daily gaining in importance as furnishing means to reduce overall finishing costs.

Mr. E. T. Candee has lined up two papers on mechanical finishing, and several additional papers dealing with new and improved methods are in sight.

Mr. F. K. Savage reported progress in the solicitation of papers on electroforming and plating applications in the graphic arts industry. The Association of Electrotypers and Stereotypers will be asked to participate in a session devoted to this subject.

Mr. B. C. Case reported that interesting developments by Dr. N. Thon and Dr. J. Kronsbein in their studies of porosity and plate distribution would be presented at the Convention.

Among the several papers offered for presentation at the miscellaneous session is one on modern methods of analysis, a very live subject today.

Offer of Convention Papers

Additional offers of papers are desired, especially in the fields indicated above. Prospective authors are requested to write to the Executive Secretary, Box 168, Jenkintown, Pa., for an "Offer Form" and "Instructions to Authors".

The deadline for receipt of manuscript (in triplicate) is January 15.

Technical Session for Ladies

At the suggestion of the Society's Executive Board it was decided to recommend to the Boston Convention that a suitable program be arranged to tell the ladies attending the Convention about the scope of electroplating and its importance in everyday life. Mr. L. Chesworth, Convention Educational Chairman and Boston Branch representative on the Editorial Board, will handle this undertaking.

Boston Convention Committee

Last month we presented Mr. Manson Glover, General Chairman of the Boston Convention Committee. This month we take pleasure in introducing his right-hand man, Dr. George P. Swift, who serves as Committee Co-Chairman.

Dr. Swift was born on August 9, 1903 in Boston and educated first in Woburn (Mass.) Public Schools and then at

George P. Swift

M. I. T. He received his S.B. and S.M. degrees in Electrochemical Engineering in 1924 and 1928 respectively and his Sc.D. degree in Metallurgy in 1944. He taught physics and metallurgy at M. I. T. between 1924 and 1944 and started independent consulting practice in 1930. In 1944 he began operating electrochemical and spectrographic laboratories in Watertown, Mass. He is a director of Alice Ames, Inc., Boston.

Many technical societies count Dr. Swift as a member. He has been particularly active in the American Electroplaters' Society, serving as an officer of its Boston Branch since 1941. He was President in 1942–1945, Assistant to the Secretary-Treasurer in 1945–1946, and has been Secretary-Treasurer since 1946. In 1947 he became Executive Secretary of the Master Metal Finishers Association of the North East, the job platers' organization in the Boston area. Beginning in 1939 he has been successively Secretary-Treasurer, Vice-Chairman and, during the past year, Chairman of the Boston Section of A. I. M. E., and is at present a Director of the National organization. In A. S. T. M. he serves as a Member of the North East District Council. He is also a member of A. S. M. and the Institute of Metals (England) and belongs to Sigma Xi, honorary engineering fraternity.

Judging from his manifold activities one would not expect Dr. Swift to have much time for anything but work. However, he did manage to get married in 1942 to Marjorie G. Quinlan and has two children, Janet E. and George P., Jr. He is also an avid reader and enjoys horticulture and color photography as hobbies.

Branch News

Coming Events

DETROIT BRANCH

ANNUAL MEETING AND DINNER-DANCE
Saturday, December 3
in Hotel Statler

Educational Session in the Afternoon

Chairman: A. E. S. President A. W. Logozzo

Speakers: W. M. Phillips and F. L. Clifton, General Motors Research Laboratories, "Instrumentation" with an instrument exhibit.
A top representative of the Armed Forces

Dinner-Dance in the Evening

Tickets at $7.50 per person from F. L. Clifton, 16536 Inverness, Detroit 21, Mich.

NEWARK BRANCH

36TH ANNUAL EDUCATIONAL SESSION AND BANQUET
Saturday, December 17

Educational Session at 2:00 P. M.

Speakers: Mr. J. B. Winters, R. O. Hull Company, Cleveland, Ohio, "Factors that Influence Operation of Chromium Plating Baths."
Dr. Samuel Heiman, Philadelphia Rust Proof Company, Philadelphia, Pa., "Deposition of Metals on Aluminum."
Mr. E. T. Candee, Lea Manufacturing Company, Waterbury, Conn., "Metal Finishing Research"

Banquet at 7:00 P. M.

Entertainment—Dancing

Tickets at $6.00 per person from George Wagner, 35 Fourth Street, Newark 7, New Jersey

BALTIMORE-WASHINGTON BRANCH

The first meeting of the season was held on October 11 in the Engineers Club, Baltimore, with an attendance of about sixty.

After a brief business session LIBRARIAN WALTER OLSON introduced A. E. S. PRESIDENT ARTHUR W. LOGOZZO, who gave an interesting talk, covering such topics as rack design, solution maintenance, the use of the spectrograph in solution analysis, nickel and chromium plating without re-racking, and the use of auxiliary anodes in chromium plating. He also showed a color movie of scenes taken by him in several plating plants which illustrated points in his talk.

KENNETH HUSTON initiated Mr. Logozzo to the Order of the Pot. A social period followed during which beer and soft drinks were served.

VERNON A. LAMB, *Secretary*

BOSTON BRANCH

The program on June 2 included besides two educational features not less than sixteen business items. Among the latter were receipt of one application for membership, a report by HAROLD NARCUS on Worcester affairs, a report by LEONARD CHESWORTH on plating classes in cooperation with Massachusetts University Extension, and the election of officers for 1949–1950. The following were elected, and installed by A. J. MINTIE:

President—LOUIS V. GAGNON
First Vice-President and *Membership Chairman*—EDMUND S. JEVELY
Second Vice-President and *Research Fund Chairman*—HAROLD NARCUS
Secretary-Treasurer—GEORGE P. SWIFT
Librarian—MANSON GLOVER
Board of Managers—ANDREW W. GARRETT, WILLIAM B. HARVEY, JAMES ANDERSON
Sergeant-at-Arms—S. J. BELLISSIMO

The librarian then presented Messrs. BEARSE and PORTER of the Worcester Film Service who showed a series of three-dimensional pictures, which were well received. Finally a Question and Answer program got under way with GEORGE B. HOGABOOM serving as moderator and ANDREW W. GARRETT as timekeeper. The very outstanding panel, which included FRED GROVER, LEONARD CHESWORTH, M. J. SHAPIRO, ARTHUR MINTIE, EDMUND S. JEVELY, LOUIS V. GAGNON, MANSON GLOVER, RALPH MCCAHAN, WILLIAM W. CHACE, HAROLD NARCUS, and the secretary, was able to cover all points raised. An informal discussion began at 10:50 P. M. when the meeting had adjourned.

GEORGE P. SWIFT, *Secretary*

BOSTON BRANCH

The Branch met on October 6 in Hotel Statler with PRESIDENT LOUIS V. GAGNON in the chair.

After applications accepted during the summer and one new application had been read and approved, MANSON GLOVER reported first that all Convention Committee chairmen had been picked and were functioning and then for the By-Laws Committee with a set of By-Laws suggested for approval. LEONARD CHESWORTH reported for the Educational Committee that starting October 18 University Extension in Massachusetts would run one elementary course in electroplating on Tuesdays at 7:30 P. M. in the M. I. T. buildings at Cambridge, with Leonard Chesworth, Chief Chemist of United-Carr Fastener Corporation, as the instructor. GEORGE P. SWIFT reported on the sessions and conferences at the Milwaukee Convention.

The chair announced the death of CHARLES O. HARDY in July and requested the members to stand one minute in silence in respect to his memory.

DR. M. M. BECKWITH, Manager of Technical Sales, Harshaw Chemical Company, Cleveland, Ohio, discussed "Easily Buffed Nickel". It is obtained from a Watts bath containing wetting agents, modifiers and anti-pitters. Reference was made to articles published this year in PLATING and *Metal Finishing* for hardness, drag-in, buffing, and plating data, and variations in the results were discussed. The method of measuring hardness could easily be misapplied, and photomicrographs were recommended as a check on the proper use of the hardness tester.

Data was then presented on variation in stress in deposits from the all-chloride, half-chloride, Perflow, Watts and Modified XXX nickel baths with changes in *p*H, temperature, and current density. Photomicrographs were shown of music recordings with the master plated in the different baths. The general result seemed to be that with soft nickel the recording lost most of the variations in tone, with the bright nickel it was noisy and high pitched, while with the grey nickel the high notes were lost. After a lengthy question and answer period the meeting adjourned at 10:30 P. M.

GEORGE P. SWIFT, *Secretary*

BUFFALO BRANCH

The first meeting of the new season was held on September 9. The evening was highlighted by the presence of MR. ROBERT K. GUFFIE who spoke on "Plating Room Headaches and Some of Their Cures." Mr. Guffie dug deep into his bag of experience to bring up some plating-room stories that were educational as well as entertaining. The high spot of the evening was a report on the new self-regulating chromium plating bath recently released by his company, United Chromium, Inc., and claimed to have 30 per cent cathode efficiency. Mr. Guffie outlined vividly the economies which could be effected by the adoption of this bath. It should be added that he had brought along his own professional heckler in the person of his brother, JIM GUFFIE, also of United Chromium, Inc.

H. A. FUDEMAN, *Secretary*

BUFFALO BRANCH

The Cavalcade of Star Speakers was continued at the October 7 meeting at which time MR. WESLEY CASSELL of the Lea Manufacturing Company, Waterbury, Conn., presented a paper on "Problems in Plating Room Equipment and Layout". In a frank but affable manner Mr. Cassell described the many evils that are visited upon many plating rooms because of poor engineering planning. He then proceeded to delineate the criteria to be considered in the selection of plating-room equipment, covering everything from the smallest pipe fittings to large plating conveyors. Mr. Cassell seemed to have impressed his audience, judging from the stimulating question period which followed.

H. A. FUDEMAN, *Secretary*

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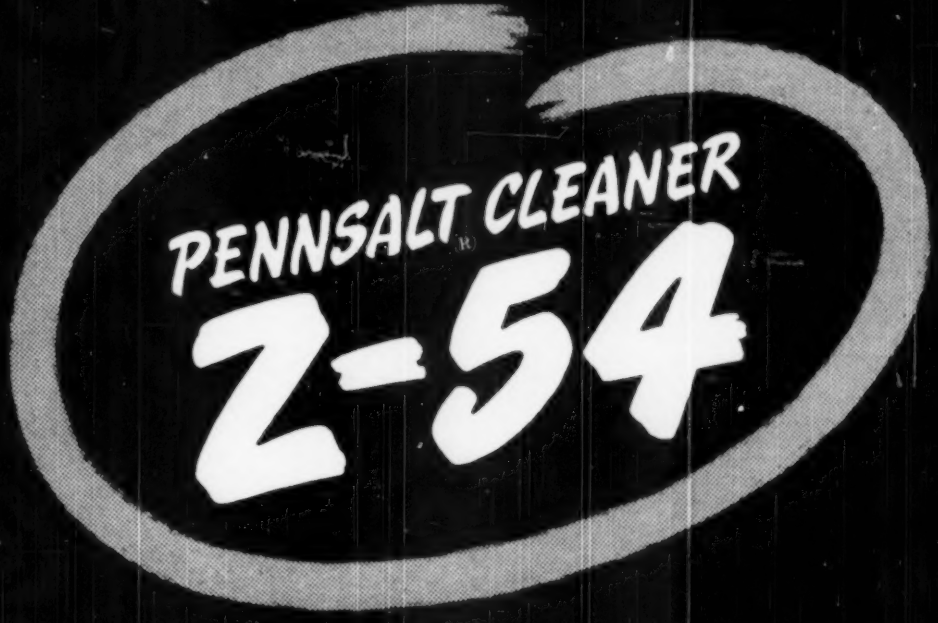

Because it allows higher current density through better conductivity and also permits the use of higher temperatures, Z-54 is especially efficient in cleaning hard to remove soil and avoiding blisters.

Z-54 contains carefully balanced anhydrous alkali ingredients plus a combination of surface active agents. Developed for reverse current cleaning prior to electroplating, it is concentrated, anhydrous, free-flowing, granular and 100% active.

This is a most important new development in the cleaning of zinc based die castings. Investigate Pennsalt Z-54 now. Our technical representative will be glad to help you set up tests. Special Chemicals Division, Pennsylvania Salt Manufacturing Company, Philadelphia 7, Pa.

PENN SALT
metal cleaning compounds

CHICAGO BRANCH

At the October 14 meeting sixty-nine members and guests were present for dinner and a total of one hundred and forty attended the general meeting.

President Glab appointed Rudy Habucha Chairman of the Banquet Committee and Bill Stocksel Sergeant-at-Arms. The Electrochemical Society was holding its annual meeting in Chicago, and twelve of its members were present and introduced at this meeting.

The speaker for the evening was Dr. Walter R. Meyer, President of Enthone, Inc., who gave an interesting talk on the theory and practice of zinc-immersion for the treatment of aluminum and aluminum alloys prior to plating. In addition he spoke about bright dipping of aluminum and presented several formulas of solutions that have been used. The usual active discussion period followed Dr. Meyer's instructive talk.

Raymond F. Ledford,
Correspondent

DAYTON BRANCH

The Christmas Party on December 10 at the Rubicon Club, with dancing, refreshments, and exchange of gifts, will take the place of the regular December meeting.

The October meeting in the Engineers' Club on October 3 was very interesting. Mr. Fred Bauch, Research Chemist, Frigidaire Plant No. 2 and a Branch member, gave a talk on "Design for Plating", including surface treatments, metal coloring, and painting. The speaker gave the general and special purposes for which all types of plating are used and how design can affect the quality and cost of the finished product. In many cases parts are designed without proper attention to whether it can be cleaned properly and plated economically. Design should allow for thicknesses needed for corrosion protection and the designer should have a knowledge of the throwing power of plating solutions. In all, the designer should keep in close contact with the electroplater and plating engineer to avoid as many of the common difficulties as possible and to secure quality finishes at the lowest possible cost. The lecture was well supported with numerous samples and was followed with a color film on "Automotive Styling". The importance and interest in this subject was shown by the lively discussion that followed.

A plant tour of McCall Corporation was made on October 17, and a good many of the members saw how a number of our leading magazines are printed. Particular interest was shown in the electrotype department, where electrotypes are made from the initial impression and silvering to the final chromium plating. This trip proved to be very interesting and educational; everyone present enjoyed it.

R. M. Clendiens, *Secretary*

DETROIT BRANCH

The meeting on October 7 had a fine turnout, apparently due to the extremely warm summer weather.

The speaker of the evening was Mr. Webb B. Knight of the Knight Plating Company, Detroit, who spoke about "Experiences in Job Shop Operations". Since Mr. Knight is also Chairman of the Branch Research Committee, he devoted a part of his talk to A. E. S. research activities. Raymond Shock acted as chairman of the educational portion of the program.

An excellent movie, "Hunting Mountain Lions", was presented by Mr. George Harding who had taken them on one of his hunting trips. They were a very fine portrayal of this active sport.

It is not too early for those who attended the last annual Stag Day to start counting on attending the next one. The date has been set for July 29. The same Committee is handling the details, assuring plenty of activity—plenty of fun.

F. J. Newton, *Librarian*

HAMILTON BRANCH

The October meeting was held on the 21st in the West Plant auditorium of the Canadian Westinghouse Company. The business consisted in announcement of appointments of Jim Beatt as Chairman of the By-Laws Committee, Earl Granfield as Chairman of the Research Committee, and Harry Deem as Chairman of the Entertainment Committee.

President W. Young introduced Mr. K. G. Wells of W. and W. Wells Company, Toronto, who described briefly the progress of the A. E. S. Research Program. He encouraged the Branch's support and asked for practical problems which would require research work and the solution of which would be of future value to Canadian electroplaters.

Dr. H. C. Kellner, Research Director of the Lea Manufacturing Company, Waterbury, Conn., addressed the meeting on the "Fundamentals of Polishing and Buffing". He dealt briefly with the basic principles of polishing and buffing and then explained in detail the operation and advantages of the Flexible Polishing and Buffing Equipment. This gained a prominent place during the recent War as a means of removing burrs and sharp edges from work in a minimum of time without destroying tolerances. The scratch pattern changes as the wheel breaks down with continued use, but with some compounds a more uniform scratch pattern is had through the life of this wheel. Finally Dr. Kellner described the recent development of liquid buffing and polishing compounds and explained their general composition and method of application. Through their use one can approach continuous operation on automatic equipment with considerable cost reduction.

Dr. Kellner illustrated his address with several lantern slides and a movie short. Several questions concerning polishing and buffing problems were asked and discussed.

The Membership Committee deserves special credit for successful efforts in enrolling new members.

G. M. Dalton, *Correspondent*

HARTFORD BRANCH

On the afternoon of October 15 a New England Reception and Dinner was given in honor of A. E. S. President Arthur W. Logozzo. It was held in the Hartford City Club, and approximately seventy members and guests were present.

Mr. Manson Glover of the Boston Branch acted as Toastmaster and in a very humorous way summarized Mr. Logozzo's career. Short talks were given by Dr. A. K. Graham, Executive Secretary, and Mr. Franklyn J. MacStoker, Third Vice-President of the Society, and by Mr. Frank L. Clifton, Secretary of the Detroit Branch. Letters or telegrams of congratulations were received from Mr. W. J. Neill, First Vice-President; Mr. C. F. Nixon, Second Vice-President, and Past Presidents S. S. Johnston, K. M. Huston and E. T. Candee, all of the A. E. S., and from the Bridgeport Branch. Mr. Logozzo received a picture painted in lacquer from "Stevie" Stephenson, Honorary Member, and a leather brief case from the members present.

The main speaker was Mr. William M. Phillips, Head of the Electrochemistry Department, General Motors Research Laboratories, whose subject was "Plating in Motion and Evaluation of Plated Deposits". Mr. Phillips illustrated his talk with slides which, from the quantity of plating done at General Motors, showed the immensity of the plating industry.

With a special projector he showed on the screen the effects of the current on the anode and cathode in small cells. The results of electrocleaning, the effect of wetting agents in the prevention of pitting in nickel plating, the effect of addition agents in preventing treeing in lead plating, and the formation of stresses in chromium plating of a partly lacquered cathode were shown. Various types of bright-nickel plating baths were mentioned, as well as cyanide copper baths. Zinc, brass, cadmium and acid copper were touched on briefly.

Due to the lateness of the hour, Mr. Phillips spoke only briefly on thickness, eye appeal (luster), and stress factors in the evaluation of deposits.

Kermit T. Simons acted as technical chairman during the question period that followed.

Stanley Platoz, *Secretary*

JACKSON-LANSING BRANCH

The Northwest Chemical Company, Detroit, was host to the Branch at its

second meeting of the season on October 11 held at the Hotel Porter, Lansing, Mich.

Following dinner, Messrs. William M. Phillips and Frank L. Clifton of the General Motors Corporation gave a talk on "Plating Solutions in Action". A unique model plating setup was used to illustrate the various steps in the plating cycle.

A sound movie entitled "Tin from Bolivia" was also shown.

More than eighty members and guests were in attendance.

Fred W. Stuckenberg,
Publicity Chairman

LANCASTER BRANCH

The annual picnic was held Saturday, August 13 at Roland Hoenstine's bungalow along the Conewago Creek. There was plenty of fun, eats and drinks for all. Thus ended the summer season which began with the annual Stag Party in Lancaster. At this event we were honored by the presence of A. E. S. Past President Kenneth M. Huston. As always his remarks were timely and of great interest.

Following the new pattern of elections the newly elected officers were installed at this meeting. They are:

President—Lester Wagner
Vice-President—Le Roy Hain
Librarian—Harry Saylor
Secretary-Treasurer—C. Smith
Board of Governors—A. W. Hagen, C. F. Bream and B. C. Reynolds

C. Smith, *Secretary-Treasurer*

LANCASTER BRANCH

The September meeting was held at the Lake Club, Spring Grove, Pa. Here the members of the Branch were the guests of the Hanover Wire Cloth Division of Continental Industries. After the excellent dinner, the speaker of the evening, Mr. G. B. Bowman, Chief Chemist of the Standard Steel Spring Company, spoke about "Corronizing", presenting a theoretical background as well as description of the process at the host plant (see picture story in February, 1949 issue of Plating) and other practical applications. Both the nickel-tin and the nickel-zinc alloying procedures were considered. Actual salt-spray panels demonstrated the amazing resistance of these coatings.

C. Smith, *Secretary-Treasurer*

LOS ANGELES BRANCH

Seventy-eight members and guests attended the regular dinner meeting held on September 14.

Librarian McDonald introduced Richard Wooley as the head of a panel on Hard Chromium Plating which included Leo Atimion of Modern Plating Company, Dexter Hallida of Tool and Jig Plating Company, Roy Lostutter of Hard Chrome Products Company, and J. Morrison, of Anachrome Corporation, all of Los Angeles. The proceedings were wire recorded and will be distributed to the members. All phases of hard chromium plating were discussed: solution composition, sulfate ratio, impurities, operating conditions, equipment, racks and racking problems, cleaning, and physical properties of deposits.

Several questions from the question box were answered.

M. H. Orbaugh, *Secretary*

MILWAUKEE BRANCH

The 403rd meeting of the Branch was held on October 7. President Bornitzke announced that the next meeting would be held at the Schroeder Hotel. Everett Robinson was appointed to handle all details at the hotel. James Paulson was appointed Research Finance Chairman. Three men were elected to membership.

A very interesting talk on everyday problems in the plating room was given by Dr. R. B. Saltonstall of The Udylite Corporation, Detroit, and was followed by a question and answer period.

After a very delicious luncheon, the meeting adjourned at 10:30 P. M.

Harry J. Krueger,
Secretary-Treasurer

MONTREAL BRANCH

Seventy-one members and guests attended the annual Banquet held in the Queen's Hotel on Tuesday evening, October 4.

A short talk was given by each of the two guests of honor. Mr. Kergen Wells of the Lea Manufacturing Company of Canada, representing the Toronto Branch, spoke about the growth of the Canadian Branches and suggested that now was the time for Montreal to start planning for a regional convention. Mr. A. M. Patience of the R. C. A. Victor Company of Montreal showed how poor plating quality can be costly in dollars and cents as well as in disappointed customers.

The turkey dinner was enjoyed by all, as well as the refreshments and entertainment which were furnished with the compliments of the supplier houses. Lucky ticket holders received a total of thirty-one prizes generously donated by the plating and affiliated firms.

J. P. Courtemanche was appointed Second Vice-President to succeed P. J. Sloane and J. G. Carrique was appointed Third Vice-President. R. E. Gordon was appointed a fourth member of the Board of Managers.

George R. King,
Secretary-Treasurer

NEWARK BRANCH

The first meeting of the Fall season was held on September 16 with forty-five people present and President Edwin Bowerman in the chair.

Secretary-Treasurer George Wagner announced the resignation of thirteen

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members and the suspension of twenty-four. There were also one out-transfer to Dayton Branch and two applications for membership.

Myron B. Diggin, a member of the A. E. S. Editorial Board, appealed for suggestions of authors of papers before the Boston Convention next June on the following subjects: "Smooth Deposits by Electrochemical Means", "Mechanical Finishing", and "Graphic Arts".

Mr. E. F. Lankes, Regional Supervisor of the Detrex Corporation, was introduced by Librarian Robert Eberhardt. His subject was "Vapor Degreasing", and a nice job of presentation was done by means of film slides synchronized with sound recordings of voices of film characters, which visualized the workings and constructions of a typical vapor degreaser.

In the discussion which followed, safety in handling of the solvent, especially trichlorethylene, was questioned. The speaker felt that no proof exists that this solvent has accumulative toxic effects. Another question of interest concerned the stabilization of trichlorethylene. More than one type of stabilizer is used because all phases in which the solvent exists must be stabilized.

Samuel S. Frey, *Recording Secretary*

NEWARK BRANCH

Forty members and guests were present at the regular meeting on October 7.

Two men were elected to membership and two new membership applications were received.

Mr. Goldberg, Director of Research, Schori Process Corporation, spoke on the subject, "Flame Spraying of Metals and Plastics", of which he gave a very vivid account. Two general methods have been developed: the wire method in which metal wires are atomized in a hydrocarbon flame, and the powder method in which finely powdered metals and plastics are blown through a flame onto a metallic or a non-metallic surface. Most metal coatings are porous, but organic coatings are non-porous. Roughening the surface by sandblasting improves adhesion. No failure has been reported in securing an electrodeposit to metal coatings of this kind. Many applications of the flame spraying method were shown, as well as the flame sprayer itself.

A number of questions were asked by members of the audience and answered by the speaker.

Samuel S. Frey, *Recording Secretary*

PHILADELPHIA BRANCH

A business meeting held at Meschach's Restaurant on October 19 was attended by fifteen officers and committee members. Principal discussion centered on the progress of arrangements for the Annual Educational Session and Banquet to be held on November 19. Reports were given which indicated an outstanding affair.

Fred Fulforth, Chairman of the Branch By-Laws Committee, read the first draft of the proposed Branch By-Laws. They were accepted with several changes, and Mr. Fulforth was instructed to get them into a form suitable for presentation to the Law Committee of the Society. They will then be drafted into final form for presentation to the members at not less than two regular meetings before adoption.

I. Wm. Marcovitch, *Secretary*

PITTSBURGH BRANCH

Approximately fifty men were present on October 13 to hear Mr. William M. Phillips, ably assisted by Mr. Frank L. Clifton, both of General Motors Research Laboratories, Detroit, Mich., present a talk titled, "Deep Sea Diving in a Plating Cell".

In this talk Mr. Phillips demonstrated in a rather simple but effective manner some of the more common reactions which occur in a plating cell. The method of presentation was unique in that an image of the cell in which the reactions took place was thrown on the screen for everyone to see. Needless to say, the discussion period which followed was very lively.

Librarian Dr. L. E. Lancy then conducted the question and answer period. Postcards have been distributed to the membership to create an interest in this feature which Dr. Lancy hopes to make a permanent part of the educational program.

Tentative plans have been made by the Librarian's Committee to hold "Milwaukee Night" on the regular meeting night in December. The Committee hopes that the feeling of good fellowship which was in evidence at all the social events at the 36th Annual Convention of the Society in Milwaukee will prevail on this night. A suitable program is being arranged.

E. J. Smith, *Secretary*

PROVIDENCE-ATTLEBORO BRANCH

A business meeting was held on August 15 to explore and develop the possibilities for the coming year. Among the items discussed were the sponsored Electroplating course at the Extension Division Rhode Island State University, topics for the regular meetings, Christmas Party, and delinquent members. It was decided to have more separate business meetings in order to save time at regular meetings.

To encourage papers by local members Technic, Inc., is offering an award of $25.00 for the best paper presented before the local branch on any phase of metal finishing by anybody actively engaged in that phase in the area served by the Providence-Attleboro Branch. The Educational Committee will handle all details.

At the first regular meeting on September 15, Mr. S. A. Lewis of the U. S. Stoneware Company, New York City, discussed "Corrosion Resistant Materials in the Plating Room". Of special interest to jewelry platers were the sections on floor construction and the Tygon (vinyl) sheet linings available for the larger rhodium installations. In addition to these products and rack coatings, many other applications of Tygon products were discussed.

Edward A. Parker, *President*

ROCHESTER BRANCH

At the regular monthly meeting in May Walter Swanton reported on the possibility of starting a library at the Rochester Institute of Technology. Election of officers for the year 1949–1950 gave the following results:

President—Joseph Hull
First Vice-President—James Weaver
Second Vice-President—Charles Hendershott
Secretary—Gordon MacDonald
Treasurer—Fred Wagner
Librarian—John Duford
Board of Managers—Robert Flint, Clinton J. Gray, John Lenzi, John Adams, Sylvester Gartland

The educational program consisted of short talks by members of the branch engaged in sales. Raymond Berghold of Frederick Gumm Chemical Company, Inc., dealt with satin finishing of aluminum by means of Clepo Sat-N-Dip, Cecil Thornton of MacDermid, Incorporated, with Rochelle tex copper, William Treadwell with lacquer problems, Frank Tinsdale with rack coatings, R. E. Waite of Hanson-Van Winkle-Munning Company with buffs, D. C. Blum of Wagner Brothers, Inc., with zinc plate and flat-top anodes, V. C. Schaeffer of Oakite Products, Inc., with a new brass cleaner.

John Adams was voted chairman for the annual Rochester and Buffalo Branches' picnic to be held this summer.

After the meeting had adjourned refreshments were served.

Gordon W. MacDonald, *Secretary*

ROCHESTER BRANCH

The September meeting was held in the Ukranian-American Club. John Adams reported on the plans of the Rochester-Buffalo picnic at Elser's Barn on September 24. All members two years or more behind in payment of dues were suspended. Third Monday of each month is the new meeting date, the Ukranian-American Club the new meeting place. Librarian John Dufford asked for suggestions of meeting topics.

The meeting was adjourned at 10:00 P. M. after which refreshments were served.

Gordon W. MacDonald, *Secretary*

ROCHESTER BRANCH

The regular monthly meeting on Monday, October 17 at the Ukranian-Ameri-

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can Club began with dinner served in the main dining room of the Club and attended by seventeen members. At the business meeting Ray Bergmold volunteered to head the Committee for the Christmas Party to be held some time in December.

Librarian John Dufford introduced the speaker, Mr. A. S. Kohler, Frederick Gumm Chemical Company, Inc., whose topic was "Barrel Burnishing". Mr. Kohler was well prepared with charts, free-hand sketches, and samples to illustrate the major points of his talk. An interesting display of sample parts being done locally had been prepared by the company's local representative, Ray Bergmold. A lengthy question and answer period followed the splendid talk.

Attendance was thirty-six members and seven guests.

Gordon W. MacDonald, *Secretary*

SAGINAW VALLEY BRANCH

One hundred and fifteen members and guests attended the meeting in Zehnder's Hotel, Frankenmuth, Michigan, on October 12.

Movies of the 1949 Michigan-Michigan State football game were shown. George Guerre, Michigan State College football star from 1946 to 1948 and now Assistant Director of Alumni Relations at Michigan State College, was the guest speaker. Guerre gained national recognition as "Little Dynamite" of the Spartan eleven. He made his debut on the gridiron in 1946 and that same year ranked thirteenth in the nation in offensive play. Both in 1946 and 1948 he won All-American honorable mention and in 1948 played in the annual North-South all-star game on Christmas Day.

Due to the length of the movie there was no business meeting. One application for membership was approved.

John W. Lee, *Recording Secretary*

ST. JOSEPH VALLEY BRANCH

The first monthly meeting of the new season was held on October 12 in Hotel Elkhart, Elkhart, Indiana. Twenty-five members and guests enjoyed the dinner and thirty-two were present for the business and technical session.

Subscription to Kalends was discontinued because the members did not receive enough benefit for the expense. Two applications for membership were received.

President Ralph Wysong presented Mr. John Lockerbie with the A. E. S. Honorary Membership Certificate. Mr. Lockerbie in accepting the presentation expressed his deep-felt appreciation to the members of the Branch and to the Society.

Dr. Ernest Wilhelm then introduced Dr. Walter R. Meyer, President of Enthone, Inc. Dr. Meyer gave a most interesting and practical informal talk on "Coloring and Bright Dipping of Metals". He covered in some detail the coloring of aluminum, zinc, copper and brass, nickel, steel, and stainless steel. Bright dipping of zinc, nickel, copper and brass, and steel was discussed briefly and illustrated with slides. A discussion period followed.

Eugene Roth,
Secretary-Treasurer

SOUTHEASTERN BRANCH

Only ten members attended the regular meeting on October 14.

After the usual business, the speaker of the evening, Dr. Fred W. Cox, Jr., a member of the Branch, gave a very interesting talk with illustrations about the research at Georgia School of Technology, of which he is Assistant Research Director. His talk was enjoyed by all present. Undoubtedly there is more talent within the Branch if we but look for it.

William Weymouth,
Secretary-Treasurer

SYRACUSE BRANCH

On September 26, forty-nine members attended a meeting at the Easy Washing Machine Corporation in Syracuse, N. Y.

The members were escorted by very competent guides on a 1½-hour tour through the manufacturing facilities. Following a half-hour sales demonstration they were taken to the Plant Cafeteria where a very excellent chicken dinner was served by the host company. A short business meeting ended the visit.

K. S. Parnell, *Secretary-Treasurer*

SYRACUSE BRANCH

The October meeting was held on the 17th in Hotel Syracuse.

Following a half-hour moving picture, "Rehearsal", presented through the courtesy of the Bell Telephone Company, Mr. Verne Nichols, Sales Manager of the Vapor Blast Manufacturing Company, presented an interesting address titled, "Principles of the Vapor Blast Process and Their Applications". He emphasized parts of his address with slides and a moving picture. Mr. Kenneth Thomas, District Engineer for the company, had a number of parts on exhibition.

Attendance was thirty-six.

K. S. Parnell, *Secretary-Treasurer*

TOLEDO BRANCH

New Branch By-Laws were adopted at the meeting in Commodore Perry Hotel on October 6.

Instead of the scheduled speaker, who could not come because of company reorganization, Mr. George Harding, President of the Harding Manufacturing Company, Detroit, Mich., showed colored moving pictures of a hunting trip in British Columbia. The Branch extends thanks to Mr. Harding for an hour of superb entertainment that will long be remembered.

G. H. Bergeman, *Secretary*

WATERBURY BRANCH

The Branch held its first meeting of the 1949–1950 season on September 9 with President George Hisert presiding and E. V. Collins acting as technical chairman. In the absence of William Stabb, Henry Strow reported on the business transactions of the Convention.

An unusual movie called "Rehearsal" was shown through the courtesy of the A. T. & T. Company. It pictured many of the behind-the-scenes preparations for the weekly "Telephone Hour" broadcast with Blanche Thebom and Ezio Pinza singing in their usual competent and enjoyable fashion.

Mr. D. C. Sanford, Application Engineer of the Bristol Company, talked about "Temperature Control of Plating Tanks", exhibiting temperature-control equipment and explaining the advantages and limitations of electrically controlled and air-operated instruments.

Sandwiches and beer were enjoyed at the close of the meeting, giving everyone an opportunity to discuss the summer happenings.

S. L. Henn, *Secretary*

WATERBURY BRANCH

At the meeting on October 14 Bert Sage, acting as technical chairman, introduced Mr. Burton G. Daw, President of Lasalco, Inc. His subject, "Cruise of the 'At Last' ", while hardly a talk on plating, was exciting and very entertaining. With color movies to illustrate, he told us of his adventures as an amateur yachtsman in a 26-foot cabin cruiser from New Haven to the St. Johns River in Florida.

Dr. George Dubpernell reviewed the book, "Tool Engineers' Handbook", published by the American Society of Tool Engineers. The book had a fair portion devoted to metal finishing, including chapters on grinding, honing, super-finishing, buffing, and polishing. Of particular interest to platers is a 40-page chapter by Arthur Zavarella of the Springfield Armory on "Surface Cleaning and Protective Coatings".

Emil Shaker, covering new developments in the plating field, called our attention to recent work on aluminum plating from nonaqueous solutions. He also pointed out a valuable article in April "Electroplating" on constant-current-density plating.

A question box is now being made a regular feature of the meetings. It is hoped that by this means an accumulation of material will be obtained for discussion at the forum which is scheduled for the latter part of this year. Questions which need an immediate answer should be so marked and will be considered at the close of each meeting. The box is located at the entrance to the Colonial Room in the Hotel Elton.

S. L. Henn, *Secretary*

Membership Report of the A. E. S.

Elections

BALTIMORE-WASHINGTON BRANCH: Carl H. Thiede

BOSTON BRANCH: Joseph Legere, William E. Porter, Jr., Robert E. Smalley

BRIDGEPORT BRANCH: Morris S. Shipley

CINCINNATI BRANCH: Orville W. Hitzemann, Ralph J. Meyer, Frank G. Miller, Jr.

DETROIT BRANCH: J. W. Buckley, R. J. Claus, H. L. Dick, Jr., W. S. Garwood, K. F. Greene, R. J. Huber, W. G. Lidtke, L. M. Radke, A. W. Reckling, S. E. Ross, R. M. Shock, W. H. Stormont, P. Undieme

HARTFORD BRANCH: Stanley Douda, Richard D. Elston

INDIANAPOLIS BRANCH: William N. Hatfield

MILWAUKEE BRANCH: Michael Brisch, John M. Clark, Robert E. Hoffman

NEWARK BRANCH: Joseph S. Calabrese, John A. Hauser, Carl J. Lang

PHILADELPHIA BRANCH: Elwood B. Bordner, Carleton C. Kimber, David K. Robson, Samuel S. Smyth, Jacob W. Tucker, Jr., Charles W. Wilson, John H. Wilson

ROCKFORD BRANCH: Harley E. Babst, Carl A. Dunk, Gordon A. Engle, Harold Gustafson, William Hratko, Stanley Setterquist, Herald C. Simon, Joe Yount

ST. JOSEPH VALLEY BRANCH: Harry S. Dietrich, Walter Lockerbie

SAGINAW VALLEY BRANCH: John H. Montgomery

SAN FRANCISCO BRANCH: Jordan F. Davis, Frederick H. Hesch

SYRACUSE BRANCH: Omer E. La Brecque, George M. Laubach, Arthur G. Martineau, Jr.

TWIN CITY BRANCH: Theodore P. Daufelt

WESTERN ONTARIO BRANCH: Leslie J. Crooks, Ralph Manning, Yoshio Shimizu, D. C. Smith

MEMBERSHIP-AT-LARGE: Pierre A. Jacquet

Reinstatements

BOSTON BRANCH: L. Axelrod, S. Baker, E. Carter, L. Doane, W. P. Galvin, L. Guilford, J. F. Haggerty, H. J. Lack, L. J. Love, M. Shapiro

BRIDGEPORT BRANCH: Charles L. Bryan, Joseph B. Filardo

COLUMBUS BRANCH: Grover C. Mills, David S. Stoker

(Continued on page 1284)

MEMBERSHIP COMPETITION

BRANCH	Membership April 1, 1949*	New Members	Net Change in Membership	Per Cent Net Change
FIRST GROUP				
DETROIT	427	58	+43	+10.1
CLEVELAND	186	12	+13	+ 7.0
NEW YORK	265	21	+11	+ 4.2
PHILADELPHIA	187	15	+ 1	+ 0.5
GRAND RAPIDS†	160			
CHICAGO	391	16	−10½	− 2.7
BRIDGEPORT	160	4	− 5	− 3.1
HARTFORD	133	8	− 7	− 5.3
PITTSBURGH	135	10	− 9	− 6.7
LOS ANGELES	217	9	−20	− 9.2
MILWAUKEE	132	9	−13	− 9.8
NEWARK	256	11	−26	−10.2
TORONTO	154	6	−17½	−11.4
BOSTON	153	7	−23	−15.0
SECOND GROUP				
MELBOURNE	81	14	+11	+13.6
BUFFALO	82	6	+ 6	+ 7.3
INDIANAPOLIS	104	6	+ 5	+ 4.8
CINCINNATI	90	3	+ 2½	+ 2.8
PROV.-ATTLEBORO	109	3	+ 1½	+ 1.3
SYDNEY†	108	8	+ 1	+ 0.9
ST. LOUIS	107	7	− ½	− 0.5
SYRACUSE	83	5	− ½	− 0.6
WATERBURY	122	3	− 1	− 0.8
BALTIMORE-WASH.	83	6	− 1½	− 1.8
NEW HAVEN	108	2	− 6	− 5.6
DAYTON	98	3	− 7½	− 7.7
ROCHESTER	125		−20½	−16.4
ST. JOSEPH VALLEY	80	2	−16	−20.0
THIRD GROUP				
SOUTHEASTERN	38	12	+ 6½	+17.1
ROCKFORD	56	8	+ 8	+14.3
COLUMBUS	38	7	+ 2½	+ 6.6
SPRINGFIELD	50	2	+ 2	+ 4.0
LOUISVILLE	20	2	+ ½	+ 2.5
LANCASTER	59	1		
MONTREAL	69	3	− 2½	− 3.6
JACKSON-LANSING	59		− 5	− 8.5
SAGINAW VALLEY†	67	3	− 6	− 9.0
TWIN CITY	77	4	− 8	−10.4
ADELAIDE	76	4	− 8	−10.5
TOLEDO	56	1	− 9½	−17.0
SAN FRANCISCO	71	13	−14	−19.7
ALLENTOWN-READING	43	1	−10½	−24.4
OUTSIDE COMPETITION				
HAMILTON		14	+20	
WESTERN ONTARIO		19	+19	
AT LARGE	100	19	− 4	
IN TRANSFER	22		− 1	
TOTAL A. E. S.	5,237	365	−94	− 1.8

Active Membership, November 1, 1949 5,143

*Subject to correction. †Winners of membership competition in 1948–1949.

Membership Report

(Continued from page 1085)

DAYTON BRANCH: Robert S. Redman

HARTFORD BRANCH: N. Mosesian, R. H. Pellington, H. B. Wilson

NEWARK BRANCH: Philip Augusta, Bennie J. Pedota

PHILADELPHIA BRANCH: Ralph D. D'Stefano, Joseph H. Lack, Levi J. Rathman

ROCHESTER BRANCH: Richard Waite

ST. JOSEPH VALLEY BRANCH: Calvin G. Smith, Charles K. Bock

TOLEDO BRANCH: Joseph Lesko

TWIN CITY BRANCH: John M. Fiekke, E. Robert Jansen

MEMBERSHIP-AT-LARGE: A. W. Hothersall

Transfers

Howard L. Wright to Baltimore-Washington Branch; Edward J. Quinlan from Boston Branch; Chester Lancaster to Cincinnati Branch; Eugene Combs to Cleveland Branch; Donald L. Patrick to Indianapolis Branch; R. Rominski from Jackson-Lansing Branch; Michael Spirito to Los Angeles Branch; Peter Pawlyk from Newark Branch; Oscar Kuntz to Toronto Branch

Resignations

CHICAGO BRANCH: Eugene C. Collins, Albert T. Smith

CINCINNATI BRANCH: Robert Monce

HARTFORD BRANCH: William Miller, Lester F. Spencer

LOS ANGELES BRANCH: Harley McQuain

NEWARK BRANCH: George Black

PITTSBURGH BRANCH: Almon S. Harmon, W. W. Wright

Suspensions

BRIDGEPORT BRANCH: Bruce L. Taylor

CHICAGO BRANCH: Harold L. Appleton, Richard W. Arms, Clarence J. Beyer, D. B. Fisher, Leonard T. Gaiser, Nelson W. Humbaugh, James O. Knight, Samuel A. Maita, T. J. Mailicki, Fred Moses, Braly S. Myers, Alfred K. Nelson, Charles F. Schiller, F. E. Wills, Paul V. Zogg

COLUMBUS BRANCH: Harold Quincel

DETROIT BRANCH: O. J. Boesch

PITTSBURGH BRANCH: Robert J. Ransome, W. H. Sutton

TORONTO BRANCH: R. Phillips

Deaths

CHICAGO BRANCH: Calvin S. Gordon

DETROIT BRANCH: R. C. Allen

A.E.S. News

(Continued from page 1075)

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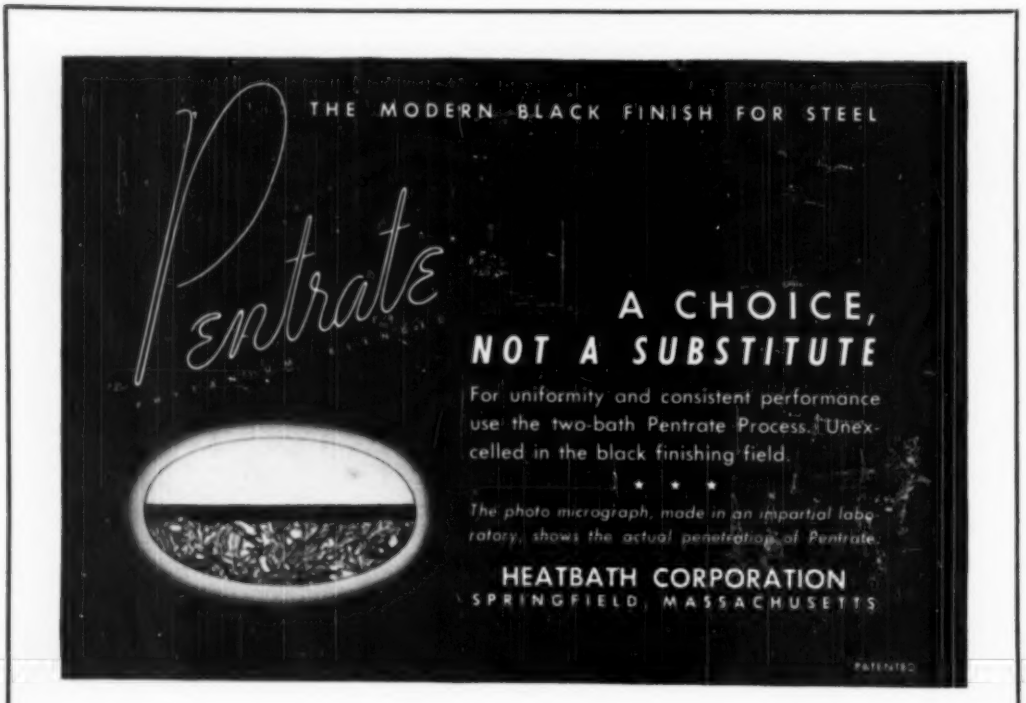
✣

Ernest Lamoureux

It is with much regret that we announce the passing, on Monday, November 7, of Ernest Lamoureux, one of the Society's early members and an Honorary Member since 1941.

He was always a diligent worker for the Society's welfare and was one of the organizers of the Chicago and St. Louis Branches. For many years he was one of the leading members of the Branch in Los Angeles where he lived at his death.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Second Vice-President . . . . . C. F. NIXON
Ternstedt Division, G. M. C.
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Third Vice-President . . . . . F. J. MacSTOKER
25 Princeton St., Garden City, N. Y.

Past President . . . . . S. S. JOHNSTON
Weirton Steel Company, Weirton, W. Va.

Executive Secretary . . . . . A. K. GRAHAM
P. O. Box 168, Jenkintown, Pa.

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Chairman . . . . . W. M. TUCKER
Eastman Kodak Company, Rochester 4, N. Y.

Secretary . . . . . The Executive Secretary

LOCAL BRANCHES

ADELAIDE, AUSTRALIA meets second Wednesday of each month. Address G.P.O. Box 598E, Adelaide, S. A., Australia.

ALLENTOWN-READING meets third Thursday of each month. Secretary-Treasurer, James F. Riegel, 425 S. 18th Street, Allentown, Pa. Research Finance Committee Chairman, G. W. Ward, 212 N. 6th Street, Allentown, Pa.

BALTIMORE-WASHINGTON meets second Tuesday of October, December, February, and April in Baltimore at the Engineers' Club, and of November, January, March, and May in Washington, D. C., at the Garden House, Dodge Hotel. Secretary, Vernon A. Lamb, National Bureau of Standards, Washington 25, D. C.

BOSTON meets first Thursday of each month in Hotel Statler. Secretary, Dr. George P. Swift, 53 Galen Street, Watertown, 72, Mass. Research Finance Committee Chairman, Eugene P. Carter, c/o United Carr Fastener Corporation, 81 Ames Street, Cambridge, Mass.

BRIDGEPORT meets first and third Friday of each month in Barnum Hotel. Secretary-Treasurer, Joseph G. Sterling, 134 Colony Street, Bridgeport 8, Conn. Research Finance Committee Chairman, Carl Schaefer, c/o Casco Products Corporation, 512 Hancock Avenue, Bridgeport 5, Conn.

BUFFALO meets first Friday of each month in Markeen Hotel. Secretary, H. A. Fudeman, 534 W. Ferry Street, Buffalo 13, N. Y. Research Finance Committee Chairman, B. P. Fortim, 200 Forest Drive, Orchard Park, N. Y.

CHICAGO meets second Friday of each month at 8 P. M. at Western Society of Engineers, 84 E. Randolph St. Secretary-Treasurer, J. M. Andrus, 3701 Ravenswood Avenue, Chicago 13, Ill. Research Finance Committee Chairman, Clyde Kelly, 740 W. Englewood, Chicago 21, Ill.

CINCINNATI meets fourth Wednesday of each month at 8 P. M. in Engineering Society Headquarters, McMillan Street and Woodburn Avenue. Secretary-Treasurer, H. Roper Davis, 6005 Yosemite Drive, Cincinnati 12, Ohio.

CLEVELAND meets first Friday of each month in Cleveland Hotel at 8 P. M. Secretary-Treasurer, Harry Pochapsky, 24961 Euclid Avenue, Cleveland, Ohio. Research Finance Committee Chairman, E. C. Friedl, c/o du Pont Company, 1335 Guardian Building, Cleveland 14, Ohio.

COLUMBUS meets first Friday of each month at 8 P. M. in Battelle Memorial Institute Auditorium. Secretary-Treasurer, Nathan L. Koslin, 2641 Cleveland Avenue, Columbus 11, Ohio.

DAYTON meets first Monday of each month in Engineers' Club. Secretary, Richard M. Clinebens, 701 W. Stewart Street, Dayton 8, Ohio.

DETROIT meets first Friday of each month in Hotel Statler. Secretary-Treasurer, F. L. Clifton, 16536 Inverness, Detroit 21, Mich. Research Finance Committee Chairman, W. B. Knight, c/o Knight Plating Company, 3143 Bellevue Avenue, Detroit 11, Mich.

GRAND RAPIDS meets second Friday of each month at 7:30 P. M. in Rowe Hotel. Secretary, Mr. F. J. Darling, 3366 College Avenue, N. E., Grand Rapids, Mich. Research Finance Committee Chairman, John W. Putte, 308 Gladstone Avenue, S. E., Grand Rapids, Mich.

HAMILTON BRANCH. Secretary, William G. Finlay, c/o The M. & Y. Products Limited, Hamilton, Ontario, Canada.

HARTFORD meets third Monday of each month in Hotel Bond. Secretary, Mr. Stanley Platoz, 26 Erwin Place, New Britain, Conn. Research Finance Committee Chairman, Frank W. Smith, 46 Cottage Street, Meriden, Conn.

INDIANAPOLIS meets first Wednesday of each month at Fox Steak House, 1207 Washington Street. Secretary, H. Smith, 335 Whittier Place, Indianapolis, Ind.

JACKSON-LANSING meets second Tuesday of each month alternating between Hayes Hotel in Jackson and Porter Hotel in Lansing. Secretary-Treasurer, E. F. Strefling, 1423 Kelsey Avenue, Lansing 10, Mich.

LANCASTER meets second Friday of each month at 8 P. M. in Thaddeus Stevens Industrial School. Secretary-Treasurer, Chester W. Smith, c/o Superior Metal Company, Bethlehem, Pa. Research Finance Committee Chairman, Harry Hovis, Lincoln Highway West, Lancaster, Pa.

LOS ANGELES meets second Wednesday of each month at 6:30 P. M. in Scully's Restaurant. Secretary, Myron H. Orbaugh, c/o Bone Engineering & Tool Company, 701 W. Broadway, Glendale 4, Calif.

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MELBOURNE, AUSTRALIA meets third Thursday of each month at 8 P. M. in Metallurgy Theatre, Melbourne Technical College, 124 Latrobe Street. Hon. Secretary-Treasurer, John J. Dale, c/o Defense Research Laboratories, Maribyrnong, Victoria, Australia.

MILWAUKEE meets first Friday of each month in Red Arrow Club, 774 N. Broadway. Secretary-Treasurer, Harry J. Krueger, 1333 S. 71st Street, Milwaukee 14, Wis. Research Finance Committee Chairman,

MONTREAL meets first Tuesday of each month in Mount Royal Hotel. Secretary-Treasurer, George R. King, P. O. Box 29, Montreal, 30, Canada. Research Finance Committee Chairman, P. M. Condy, c/o R. C. A. Victor Company, 1001 Lenoir Street, Montreal, P. Q., Canada.

NEWARK meets first and third Friday of each month at 8 P. M. in Hotel Robert Treet. Secretary-Treasurer, George Wagner, 1130 S. Long Avenue, Hillside, N. J. Research Finance Committee Chairman, Edwin Bowerman, 166-41 17th Avenue, Whitestone, N. Y.

NEW HAVEN meets second Tuesday of each month alternating between Sterling Chemistry Laboratory, Yale University, and Hotel Taft. Secretary-Treasurer, B. J. Gaffney, 40 Filbert Street, Spring Glen, Hamden 14, Conn. Research Finance Committee Chairman, Henry B. Smith, c/o R. Wallace & Sons, Wallingford, Conn.

NEW YORK meets second and fourth Fridays of each month in Statler Hotel. Secretary-Treasurer, Franklyn MacStoker, 25 Princeton Street, Garden City, L. I., N. Y. Research Finance Committee Chairman, George F. Hermann, 52 Chestnut Street, Brooklyn 8, N. Y.

PHILADELPHIA meets fourth Friday of each month in Harrison Laboratory Building, University of Pennsylvania, 34th and Spruce Streets. Secretary, I. William Marcovitch, 1434 Lardner Street, Philadelphia 24, Pa. Research Finance Committee Chairman, Al Hirsch, 1945 W. Airdrie Street, Philadelphia 40, Pa.

PITTSBURGH meets second Thursday of each month in the Avon Room of Sheraton Hotel. Secretary-Treasurer, E. J. Smith, Chem. Dev. & Res. Lab., Weirton Steel Co. Weirton, W. Va Research Finance Committee Chairman, R. A. Woofter, 42 Hiland Ave., Emsworth, Pittsburgh 2, Pa.

PROVIDENCE-ATTLEBORO meets third Monday of each month in Providence-Biltmore Hotel. Secretary, Irving H. Eastman, 79 Spofford Road, Lakewood 5, R. I. Research Finance Committee Chairman, Pierre B. Lonsbury, 78 North Ave., Attleboro, Mass.

ROCHESTER meets third Monday of each month in Ukranian-American Club. Secretary, Gordon W. MacDonald, North Bergen Road, R. D. No. 1, Bergen, N. Y. Research Finance Committee Chairman, Cecil Thornton, 20 Lafayette Parkway, Rochester, N. Y.

ROCKFORD meets second Monday of each month in Faust Hotel. Secretary, Vern T. Wissen, Spring Creek Road, Rockford, Ill. Research Finance Committee Chairman, Al Overbie, c/o National Lock Company, Rockford, Ill.

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ST. JOSEPH VALLEY meets first Wednesday of each month at 8 P. M. in Hotel Elkhart, Elkhart, Ind. Secretary-Treasurer, Eugene Roth, 1720 Mishawaka Avenue, South Bend 15, Ind. Research Finance Committee Chairman, Ray Friend, 1435 Howard Street, Niles, Mich.

ST. LOUIS meets second Wednesday of each month in York Hotel. Secretary-Treasurer, E. R. Hunleth, 4415 Michigan Avenue, St. Louis, Mo. Research Finance Committee Chairman, H. Siegel, c/o Siegel-Roberts Plating Company, 4193 Manchester, St. Louis, Mo.

SAN FRANCISCO meets second Thursday of each month, alternating between El Jardin Restaurant, 22 California Street, San Francisco, and El Curtola Restaurant, 510 17th Street, Oakland. Secretary-Treasurer, John J. Meehan, 1345 16th Avenue, Apt. 4, San Francisco, Calif.

SOUTHEASTERN meets second Friday of each month in Robert Fulton Hotel, Atlanta, Ga. Secretary, William Weymouth, 173 Clay Street, S. E., Atlanta, Ga. Research Finance Committee Chairman, Dr. Fred W. Cox, 917 S. 20th Street, Birmingham, Ala.

SPRINGFIELD meets fourth Monday of each month in Hotel Charles. Secretary, James Laing, 93 Woodbridge Street, South Hadley, Mass. Research Finance Committee Chairman, James Laing, c/o Van Valkenburg Company, Montgomery Street, Willamansett, Mass.

SYDNEY, AUSTRALIA. Secretary-Treasurer, T. O. Kolts, 7 King Street, Newtown, Sydney, N. S. W., Australia.

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TOLEDO meets first Thursday of each month at Commodore Perry Hotel. Secretary, Gaston Bergeman, 703 Pine Street, Fremont, Ohio.

TORONTO meets second Friday of each month in Royal York Hotel. Secretary, R. Stevens, c/o Bryden Brass Company, 927 Dufferin Street, Toronto, Canada. Research Finance Committee Chairman, C. D. Short, 1281 Pape Avenue, Toronto, Canada.

TWIN CITY meets first Monday of each month, October through June, in Covered Wagon Cafe, Lodge Room, 114 S. 4th Street, Minneapolis. Secretary-Treasurer, Robert L. Buckley, 316 Builders Exchange, Minneapolis 2, Minn. Research Finance Committee Chairman, Gunnar Deedon, 3650 47th Avenue S., Minneapolis, Minn.

WATERBURY meets second Friday of each month in Elton Hotel. Secretary-Treasurer, Spencer L. Henn, P. O. Box, Dr. B, Cheshire, Conn. Research Finance Committee Chairman, Anthony Maz, c/o Risdon Manufacturing Company, Waterbury, Conn.

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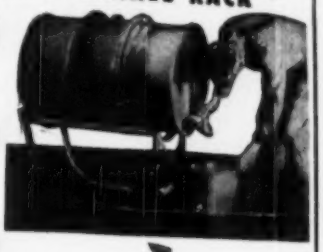

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December 1, 1949

Dear Reader:

First of all, the Editors and Associate Editors wish you a Merry Christmas, including everything that your heart may desire: a well-filled stocking and above all real peace of mind.

This being the last issue of the year we feel moved to thank you for your forbearance with mistakes and errors in the past twelve issues and for the splendid cooperation which we have received from so many of you.

These thanks go not only to authors of articles and suppliers of news items, book reviews and abstracts, but also to those who have voiced disagreements by writing to the Editor's Mailbox or who have sent in questions that could be used in the Question Box or who have helped to answer such questions.

Last but not least we wish to thank all who have made it a habit to mention PLATING when they write directly to an advertiser. Their cooperation is as important to the success of a journal as that of anyone else.

Thanks to all of you and, again, Merry Christmas!

Sincerely,

Gustaf Soderberg

Future Meetings

DETROIT BRANCH, A. E. S. Annual Educational Session and Banquet on December 3.

NEWARK BRANCH, A. E. S. 36th Annual Educational Session (2:00 P. M.) and Banquet (7:00 P. M.) in Robert Treat Hotel on Saturday, December 17.

PLANT MAINTENANCE SHOW AND CONFERENCE in the Auditorium, Cleveland, Ohio, on January 16–19, 1950.

AMERICAN SOCIETY FOR TESTING MATERIALS Committee Week and Spring Meeting in Hotel William Penn, Pittsburgh, Pa., on February 27–March 3, 1950.

NATIONAL PRODUCTION EXPOSITION of the Chicago Technical Societies Council in Stevens Hotel, April 4–8, 1950, 1:00–10:00 P. M.

AMERICAN ELECTROPLATERS' SOCIETY 37th Annual Convention and the 4th International Conference on Electrodeposition in Statler Hotel, Boston, Mass., on June 12–15, 1950.

AMERICAN SOCIETY FOR TESTING MATERIALS 53rd Annual Meeting and 9th Exhibit of Testing Apparatus and Related Equipment in Chalfonte-Haddon Hall, Atlantic City, N. J., on June 26–30, 1950.

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